National Library of Canada
Acquisitions and Bibliographic Services Branch
395 Wellington Street
Ottawa, Ontario
K1A 0N4

Bibliothèque nationale du Canada
Direction des acquisitions et des services bibliographiques
395, rue Wellington
Ottawa (Ontario)
K1A 0N4

Your file Votre référence

Our file Notre référence

NOTICE

The quality of this microform is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us an inferior photocopy.

Reproduction in full or in part of this microform is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30, and subsequent amendments.

AVIS

La qualité de cette microforme dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de qualité inférieure.

La reproduction, même partielle, de cette microforme est soumise à la Loi canadienne sur le droit d'auteur, SRC 1970, c. C-30, et ses amendements subséquents.

Canada

UNIVERSITY OF ALBERTA

RECREATIONAL ICE HOCKEY INJURIES

BY

DONALD CLAIR VOAKLANDER

A thesis submitted to the Faculty of Graduate Studies in partial fulfillment of the requirements for the degree of **DOCTOR OF PHILOSOPHY**

DEPARTMENT OF **PHYSICAL EDUCATION AND SPORT STUDIES**

Edmonton, Alberta

Fall, 1994

National Library
of Canada

Acquisitions and
Bibliographic Services Branch

395 Wellington Street
Ottawa, Ontario
K1A 0N4

Bibliothèque nationale
du Canada

Direction des acquisitions et
des services bibliographiques

395, rue Wellington
Ottawa (Ontario)
K1A 0N4

Your file Votre référence

Our file Notre référence

The author has granted an irrevocable non-exclusive licence allowing the National Library of Canada to reproduce, loan, distribute or sell copies of his/her thesis by any means and in any form or format, making this thesis available to interested persons.

L'auteur a accordé une licence irrévocable et non exclusive permettant à la Bibliothèque nationale du Canada de reproduire, prêter, distribuer ou vendre des copies de sa thèse de quelque manière et sous quelque forme que ce soit pour mettre des exemplaires de cette thèse à la disposition des personnes intéressées.

The author retains ownership of the copyright in his/her thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without his/her permission.

L'auteur conserve la propriété du droit d'auteur qui protège sa thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

ISBN 0-315-95277-6

Canada

UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR: **Donald Clair Voaklander**

TITLE OF THESIS: **Recreational Ice Hockey Injuries**

DEGREE: **Doctor of Philosphy**

YEAR THIS DEGREE GRANTED: **1994**

Permission is hereby granted to the University of Alberta Library to reproduce single copies of this thesis and to lend or sell such copies for private, scholarly, or scientific research purposes only.

The author reserves all other publication and other rights in association with the copyright in the thesis, and except as hereinbefore provided neither the thesis nor any substantial portion thereof may be printed or otherwise reproduced in any material form whatever without the author's prior written permission.

8 Guilford St.
Sherwood Park, AB
T8A 3H2

Date July 13/94

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled **RECREATIONAL ICE HOCKEY INJURIES** Submitted by **DONALD CLAIR VOAKLANDER** in partial fulfillment of the requirements for the degree of **DOCTOR OF PHILOSOPHY**.

H. Arthur Quinney

Ross B.J. Macnab

L. Duncan Saunders

David C. Reid

Brian Fisher

Date 4.7.94

Dedication

I dedicate this thesis to my parents, Bob and Jessie Voaklander

Abstract

The purpose of this thesis was to examine the nature and incidence of adult male recreational ice hockey injuries.

A total of 833 ice hockey injuries from all levels of hockey over a 1 year period reported to 2 emergency departments from Kingston, Ontario were examined. The injury rate for males was 5.9 injuries/1000 participant-hours. The predominant anatomic site injured was the lower extremity (25%), the most common diagnosis was bruising (40%), and the most common mechanism was collision (excluding body checks) (25%). It was determined that players suffering facial injuries were older than those suffering injuries at other anatomic sites. It was hypothesized that because it is not a requirement to wear facial protection among older recreational players, they are at a higher risk for facial injuries. It was also found, that in general, players wait too long before seeking treatment for their injuries.

A descriptive analysis was conducted for injuries suffered by 431 subjects playing adult recreational hockey in Edmonton, Alberta. One hundred injuries were reported by 287 athletes playing hockey in adult male recreational leagues comprising players aged 18 years and older. Fifty-one injuries were reported by 144 athletes playing hockey in old-timer leagues comprising players aged 30 years and older. The predominant anatomic site injured was the lower extremity (34%), the most common diagnosis was sprain/strain (39%), and players were most often injured as a result of stick contact (23%). It was concluded that players without facial protection were at a significantly greater risk of facial injury.

A risk factor analysis of the 287 adult recreational ice hockey players suffering 100 injuries from Edmonton, Alberta. Risk factors for any injury included skilled trades occupation, participation in strength training, an injury in the previous year, and shooting on the left. A risk factor for facial injury was found to be shooting on the left. Risk factors for body contact injuries included lower weight, lower body mass index, decreased use of alcohol, and student occupational status. Risk factors for strain/sprain injuries included increased age and skilled trades occupational status.

The present research was the first comprehensive study of adult recreational ice hockey. The methods used here could be applied to the investigation of injuries suffered by other recreational populations.

Preface

The reader of this thesis should note that it is presented in the paper-format. This means that each chapter is presented with its own set of references, its own introduction, etc.

For this particular thesis, chapters 2 through 4 are written with the intention that they will be subsequently submitted for publication (chapter 2 is presently in print). Chapter 3 and 4 use the same data set and are respectively, descriptive and analytic in nature.

Acknowledgments

I would like to thank the following for their valued contribution to this thesis.

The Canadian Fitness and Lifestyle Research Institute - for funding this research in its entirety.

Dr. Ross Macnab, Dr. Art Quinney, and Dr. L. Duncan Saunders - a very special appreciation for their advice and guidance.

Dr Rob Brison for his assistance with the Kingston project.

The hockey league officials in Kingston, ONT and Edmonton, AB - without their participation, these projects would not have been possible.

The recreational hockey players in Edmonton, AB - without their participation, the major portion of this research would not have been possible.

And finally, I would like to thank my wife Karen, for her advice, encouragement, and support in the completion of this thesis.

Table of Contents

Chapter 1 INTRODUCTION
- 1.1 Introduction 1
- 1.2 Injury Rates, Mechanisms, and Anatomical Distribution of Ice Hockey Injuries 1
- 1.3 Risk Factors for Ice Hockey Injuries 4
- 1.4 Reasons Why Injury Research With Recreational Players is Important 6
- 1.5 References 7

Chapter 2 ICE HOCKEY INJURIES TREATED IN TWO EMERGENCY DEPARTMENTS
- 2.1 Introduction 10
- 2.2 Methods 10
- 2.3 Results 11
- 2.4 Discussion 16
- 2.5 Conclusions 18
- 2.6 References 18

Chapter 3 THE EPIDEMIOLOGY OF RECREATIONAL AND OLD-TIMER ICE HOCKEY INJURIES
- 3.1 Introduction 21
- 3.2 Methods 21
- 3.3 Results 22
- 3.4 Discussion 29
- 3.5 Conclusions 31
- 3.6 References 32

Chapter 4 PERSONAL RISK FACTORS FOR INJURY IN RECREATIONAL ICE HOCKEY
- 4.1 Introduction 34
- 4.2 Methods 34
- 4.3 Results 35
- 4.4 Discussion 44
- 4.5 Conclusions 46
- 4.6 References 47

Chapter 5 OVERVIEW AND FUTURE DIRECTIONS
- 5.1 Overview 49
- 5.2 Future Directions 50
- 5.3 References 51

APPENDICES 52

List of Tables

Table 1-1	Ice hockey research summary	5
Table 2-1	When treatment was sought following injury	14
Table 2-2	Anatomical distribution of injury mechanisms (male)	14
Table 2-3	Diagnostic distribution of injury mechanisms (male)	15
Table 2-4	Anatomical distribution of injury diagnoses (male)	15
Table 3-1	Subject demographics	23
Table 3-2	Anatomical distribution of injury	24
Table 3-3	Diagnostic distribution of injury	27
Table 3-4	Mechanisms of injury	28
Table 3-4	Where players sought treatment	29
Table 3-5	Injury severity as a function of time lost from hockey	29
Table 4-1	Subject demographics	36
Table 4-2	Risk factors for any injuries - bivariate logistic regression	37
Table 4-3	Risk factors for any injuries - multiple logistic regression	38
Table 4-4	Risk factors for facial injuries - bivariate logistic regression	39
Table 4-5	Risk factors for facial injuries - multiple logistic regression	40
Table 4-6	Risk factors for body contact injuries - bivariate logistic regression	41
Table 4-7	Risk factors for body check injuries - multiple logistic regression	42
Table 4-8	Risk factors for strain/sprain injuries - bivariate logistic regression	43
Table 4-	Risk factors for strain/sprain injuries - multiple logistic regression	44

List of Figures

Figure 2-1 Age distribution of persons reporting injuries 12
Figure 2-2 Distribution of lower extremity injuries for males and females 13
Figure 2-3 Distribution of upper extremity injuries for males and females 16

Figure 3-1 Distribution of head/neck/face injuries (AMRL) 24
Figure 3-2 Distribution of head/neck/face injuries (OTL) 25
Figure 3-3 Distribution of upper extremity injuries (AMRL) 25
Figure 3-4 Distribution of upper extremity injuries (OTL) 26
Figure 3-5 Distribution of lower extremity injuries (AMRL) 26
Figure 3-6 Distribution of lower extremity injuries (OTL) 27

CHAPTER 1

INTRODUCTION

1.1 Introduction

There is little doubt that a physically active lifestyle decreases an individual's chances of succumbing to death or disability from cardiovascular disease or a variety of obesity related conditions (24). The types of physical activities that individuals participate in may, however, have their own inherent risks from injury. Team sports of the contact variety, of which ice hockey is one, have their own types of risks, many of which are caused by collisions with other players and/or the playing environment (1). Based on emergency visits (2,31) and surveys (19,36), ice hockey is a leading cause of sport and recreation injuries in Canada. Additionally, studies that have controlled for exposure have reported that ice hockey is the predominant injury related contact/collision sport (2,6,16,17).

The extraordinary rise in popularity of adult recreational ice hockey, particularly at the old-timer level, demands that efforts be made to ensure the safety of participants. While an estimate of numbers involved is illusive, but one study found that approximately 37% of all hockey ice time in Ontario was used by adult recreational hockey players (8).

Almost all of what we know about the incidence, mechanisms, and types of ice hockey injuries comes from studies collecting data from minor, junior, collegiate, and professional leagues. These studies are outlined in the following sections and are summarized in Table 1-1.

1.2 Injury Rates, Mechanisms, and Anatomical Distribution of Ice Hockey Injuries

All insurable injuries were examined for the 1963-64 season of the Toronto Township Hockey League (37). A total of 85 injuries were reported for the 2,469 children (ages 7-18 years) participating. The face and head were most often injured accounting for 56 injuries, while the other 29 were distributed about the body. The most common reported cause of injury was the stick (17 injuries), followed by the puck (13 injuries), and the boards (12 injuries). Older players suffered a higher injury frequency than younger players.

An analysis of injury insurance data found that for the years 1967 and 1968, a total of 3,895 injuries were reported for 65,881 registered hockey players in Czechoslovakia (12). Head injuries accounted for 36.7% of all injuries while 35.7% injuries were to the lower limbs. The most common injury mechanism was found to be collisions with sticks/pucks (53.9%) followed by impact with players or the boards (32.2%).

Using data supplied by coaches, team managers, and physicians, injuries were tabulated for the 1971-72 and 1973-74 hockey seasons for all junior, juvenile, and midget hockey teams in the province of Ontario (9). Lacerations were the most often reported accounting for 149 of the 542 injuries reported, followed by contusions (124) and fractures (108). The hockey stick was the

predominant cause of lacerations (68%), while contact with the boards was the number one cause of contusions (28%) and fractures (26%).

Analyzing injury reports made by team physicians and/or trainers, Hayes (10) reported on the incidence and nature of injuries suffered by 21 Canadian and 9 American intercollegiate hockey teams. 328 injuries were reported during 280 games. Head and face injuries accounted for 45.1% of all injuries followed by knee injuries (10.4%) and the neck or shoulders (9.2%). Injuries were most often caused by body contact (38.3%), the stick (29.1%), and the puck (15.2%).

An investigation into the incidence of hockey injury for all minor, junior, university intramural, and university intercollegiate players in the greater Edmonton metropolitan area revealed an overall rate of injury of 6.5% for the 1969-70 season (25). Incidence of injury increased by age from 1.5% for those aged 9-10 to 25.2% for those aged 17-18. Head and facial injuries accounted for 42.9% of the 446 reported injuries. Lacerations accounted for 34.8% of all injuries with the next most common injury being fractures (12.8%). The most common cause of injuries was the stick (32.7%), followed by the puck (17.7%) and the boards (15.9%).

Sutherland (32) examined the incidence and nature of injuries suffered during the 1974-75 season for 706 minor hockey players, 207 high school players, 25 varsity players, and an International Hockey League team, all based in Toledo, Ohio. For minor hockey 58.7% of the injuries were to the face or head (including concussions 11.7%) and 23.7% were to the knee. For high school hockey 68.2% of the injuries were to the face or head (including concussions 7.3%). For varsity hockey players 26.6% of the injuries were to the head or face (including concussions 3.3%) while 26.6% were to the groin area. For the IHL team 66.7% of injuries were to the head or face (including concussions 5.9%) with the remainder of injuries being distributed evenly about the body.

Over a 5 year period injuries were tabulated for a single NCAA team from New York University at Buffalo (27). The injury rate was found to be 7.9/100 hours of play for the 104 injuries recorded. The most common site of injury was the face (17.3%) followed by the knee (13.6%). Player contact accounted for the bulk of injuries (43%).

Data was gathered retrospectively at the end of two seasons of hockey for 14 Danish elite hockey teams via questionnaires (13). The injury rate for games was found to be 38/1000 player hour. The head received most of the injuries (28%) while the lower extremities received 27% of all injuries. No information on mechanism of injury was reported.

A retrospective survey at the conclusion of the 1982-83 season was completed by 251 players and 12 coaches on 12 high school hockey teams in the Minneapolis-St. Paul area (7). A rate of 75 injuries per 100 players or 5/1000 person hours of practices and games was reported. The most often reported injury was contusion (29%), followed by laceration (13%) and concussion (12%). Player contact accounted for 34.8% of the injuries while contact with the boards or net accounted for 30.0%.

The rate and circumstance of injury for the Swedish national hockey team was reported for a total of 40 games played during both the Canada Cup Tournament and the World Championships in 1984 and 1985 (14). A total of 36 injuries were catalogued with 18 of these being facial lacerations. The rate of injury associated with player absence was calculated to be 79.2/1000 player-

game hours. Player contact and checking accounted for 73.8% of the injuries to the body. Eighty-three percent of the facial lacerations were caused by stick contact.

Lorentzon et al. (15) followed a Swedish elite hockey team for three seasons (1982 to 1985) registering the incidence of injury. The incidence of injury during practice was found to be 1.4/1000 player-practice hours and 78.4/1000 player-game hours. The most common injuries were contusions (32.9%) followed by strains (17.1%) and sprains (15.8%). The most common mechanism of injury was checking or player contact (57.9%), followed by puck (14.5%) and stick (11.8%)contact.

A comparison was made between the injury rate for pee-wee hockey leagues that allowed body checking and one that did not (26,28). In the checking league, serious injuries occurred six times more often than in the non-checking league. In the checking league, the major mechanism of injury was checking (55.5%), while in the non-checking league no clear cut main mechanism was delineated (checking 18.8%; stick contact 18.8%; puck contact 18.8%).

All twelve Swedish elite hockey teams were followed prospectively for the 1988-89 hockey season to investigate the frequency and nature of their injuries (35). A total of 285 injuries were documented of which 9% were classified as major. The head/facial area was most commonly injured (39%) followed by the lower extremity (32%). Injuries were most commonly caused by the hockey stick or by player collisions/body checks.

A prospective study of 150 male ice hockey players aged 9 through 15 was conducted to determine the nature and frequency of injury as well as players', coaches', and parents' attitudes towards the reduction of injuries (3). One in three players were injured such that their participation was limited for a least a portion of a game. Illegal checks were found to be associated with 66% of all injuries while only 14% resulted in penalties. One in three games that resulted in an injury were described as hostile. The authors concluded that the elimination of body checking for prepubertal boys and enhanced rule enforcement and good sportsmanship would do much to reduce injuries.

McKnight et al. (18) followed 7 varsity hockey teams for 3 years. A total of 280 injuries were reported over this period that gave a rate of 20.0/1000 player-exposures. The lower extremity was the anatomic site that had the most reported injuries (52%). The bulk of player injuries were caused by player contact (79%).

Pelletier et al. (23) examined intercollegiate hockey injuries over six hockey seasons (1979-85) using the CAIRS (Canadian Athletic Injury Reporting System). Injury rates were determined to be 19.95/1000 player-exposures or 58.2/100 players. Sprains/dislocations were the predominant diagnosis (31.0%). The most common mechanism of injury was legal body-checking (44.6%) while the lower extremity was the most often the site of injury (39.9%).

In addition to the work outlined above, in Canada, ongoing surveys of blinding eye injuries have resulted in recommendations in the design and utilization of facial protection for hockey players (20-22). Also, a similar type of survey conducted in Canada examining catastrophic spinal injuries in ice hockey has resulted in recommendations concerning the physical conditioning and training of young ice hockey players, as well as a call to institute and enforce rules concerning cross-checking and checking from behind (33,34).

It would seem from this information that the majority of injuries occur to the head and face. The mechanisms of injury most often cited are stick contact and collisions with other players or objects in the playing environment (net, boards, or ice). Injury rates vary considerably by age, level of competition, injury definition, and data collection methods.

1.3 Risk Factors for Ice Hockey Injuries

Research has shown that forwards tend to be injured more often than both defencemen and goal tenders (10,11,25). Age is also a factor with a distinctive trend towards a higher injury frequency for older age groups of players[1] (4,11,25). The use of face protectors has been also been associated with a reduction in facial lacerations and eye injuries (14,15,22). Additionally, the removal of body checking from minor hockey has also brought about reductions in the occurrence of injuries (26,28). Hostile and aggressive behaviors have also been found to contribute to the occurrence and nature of injuries among hockey players (3,30).

[1]This is at least true for minor hockey through junior and collegiate hockey levels. It is unknown what the effect of age is on injury rates in adult recreational hockey.

Table 1-1
Ice hockey injury research summary

Study	Location/Population/ Data Source	Rate	Most Common Anatomy	Most Common Diagnosis	Most Common Mechanism
Toogood (1966)	Toronto/7-18 yrs./Insurance Rec.	34/1000 Participants	Mouth (25%)		Stick (20%)
Hornof (1973)	Czechoslovakia/All levels/ Insurance Rec.	30/1000 Participants	Head (37%)		Stick/Puck (54%)
Hastings (1974)	Ontario/15-21 yrs./Survey of coaches, managers			Laceration (27%)	Stick (41%)
Hayes (1975)	Canada-U.S/Varsity/ Physicians, trainers	1.17/Game	Head/Face (45%)	Soft tissue (88%)	Player Contact (38%)
Reeves (1975)	Edmonton/Minor-Varsity/ Coaches, trainers, etc.	65/1000 Participants	Head/Face (43%)	Laceration (35%)	Stick (33%)
Sutherland (1976)	Ohio/5-14 yrs./ Coaches, trainers, interviews	24/1000 Participants	Head/Face (53%)	Laceration (53%)	
	Ohio/High School/ Coaches, trainers, interviews	198/1000 Participants	Head/Face (66%)	Laceration (64%)	
	Ohio/Varsity/ Coaches, trainers, interviews	1200/1000 Participants	Head/Face; Groin (27%)	Laceration (27%)	
	Ohio/Professional/ Coaches, trainers, interviews	2040/1000 Participants	Head/Face (67%)	Laceration (63%)	
Rielly (1982)	Buffalo/Varsity/Trainers	7.9/100 Hours	Head/Face (35%)	Laceration (29%)	Player Contact (43%)
Jørgensen (1986)	Denmark/Elite Men/Player survey	11.9/1000 Player-exposures	Head/Face (37%)	Contusion (46%)	
Gerberich (1987)	Minnesota/ High School/Player, coach survey	750/1000 Participants	Head (17%)	Contusion (29%)	Player Contact (35%)
Lorentzon (1988)	Sweden/ National Team Tournaments/ Physician	24.8/1000 Player-exposures	Head/Face (50%)	Laceration (50%)	Player Contact (74%)
Lorentzon (1988)	Sweden/Elite Men/ Physician	24.5/1000 Player-exposures	Lower Extremity (41%)	Contusion (33%)	Player Contact (58%)
Regnier (1989); Roy (1989)	Quebec/ 12-13yrs; Body Checking/ Survey, observers	62 Fractures/ 1000 Games			Body Checking (55%)
	Quebec/ 12-13yrs; No Body Checking/ Survey, observers	4 Fractures/ 1000 Games			Body Checking; Stick; Puck (19%)
Tegner (1991)	Sweden/Elite Men/ Physicians	16.6/1000 Player-exposures	Head/Face (39%)	Strain/ Sprain (24%)	Stick (30%)
Brust (1992)	Minnesota/ 9-15 yrs./ Coaches, managers, observers	35/1000 Participants	Head/Neck (23.2%)	Contusion (50%)	Player Contact (86%)
McKnight (1992)	Eastern NCAA/Varsity/ Trainers	10.2/1000 Player-exposures	Lower Extremity (52%)	Strain/Sprain (44%)	Player Contact (42%)
Pelletier (1993)	Ottawa/Varsity/ Physicians, trainers	20.0/1000 Player-exposures	Lower Extremity (39%)	Strain/ Sprain (42%)	Player Contact (79%)

1.4 Reasons Why Injury Research With Recreational Players is Important

In summary; past studies of hockey injuries have concentrated on minor, junior, intercollegiate, or professional hockey. There are several reasons why new injury research with recreational hockey players is important:

1) Almost all of what we know about the incidence and nature (anatomy, diagnosis, mechanism) of ice hockey injuries is from studies that have not examined a recreational population. Information derived from recreational athletes can help determine the level of risk for this sporting sub-population.

2) The identification of a risk factor profile for recreational hockey has not been established. Existing risk profiles have derived their information from studies of minor, junior, intercollegiate, and professional hockey (4,5,11,29). Because the data for these studies are derived from substantially different populations, their generalizability to recreational athletes may be problematic.

3) From a planning standpoint, injury information derived from a recreational sample is useful to programmers interested in offering a wide range of safe recreational sport options.

4) Recent information suggests there is a rise in the number of catastrophic eye injuries suffered among adult recreational hockey players (4). If this is the case, a quantitative analysis of the mechanism of facial injury as well as the protective equipment worn is suggested for recreational hockey players.

5) Recreational hockey leagues have prohibited intentional body contact and in the case of old-timer leagues, have prohibited the slap shot. It is important to determine the nature and anatomical distribution of injuries observed in leagues that have instituted these rule modifications because the potentional effects of these modifications have not been quantified.

The following chapters present information that addresses these areas.

1.5 References

1 Arnheim DD: *Modern Principles of Athletic Training.* St. Louis: CV Mosby Company, 1985.

2 Brison RJ, Voaklander DC, Quinney HA, Macnab RBJ: *The epidemiology of contact sport injuries treated in an emergency department.* Research report made to the Canadian Fitness and Lifestyle Research Institute, 1992.

3 Brust JD, Leonard BJ, Pheley A, Roberts WO: Children's ice hockey injuries. *A J Dis Child* 1992;146:741-747.

4 Castaldi CR, Sparacio L, Wood AS, Bernard J. Injury rates in amateur, college, and professional hockey. In: Castaldi CR , Hoerner EF, ed. *Safety in Ice Hockey.* Philadelphia: ASTM, 1989:14-28.

5 Daly PJ, Sim FH, Simonet WT: Ice hockey injuries a review. *Sports Med* 1990;10:122-131.

6 Dzenowagis JG: Injuries in men's intramural activities at Michigan State University. *Student Med* 1962;10:441-449.

7 Gerberich SG, Finke R, Madden M, Priest JD, Aamoth G, Murray K: An epidemiological study of high school ice hockey injuries. *Child's Nerv Syst* 1987;3:59-64.

8 Getz D: *Ice Use in Ontario Arenas.* Waterloo: University of Waterloo, 1988.

9 Hastings DE, Cameron J, Parker SM, Evans J: A study of hockey injuries in Ontario. *Ontario Med Rev* 1974;Nov:686-698.

10 Hayes D: The nature, incidence, location and causes of injury in intercollegiate ice hockey. In: Taylor AW, ed. *Application of Science and Medicine to Sport.* Springfield: Thomas Publishing, 1975:292-300.

11 Hayes D: An injury profile for hockey. *Can J App Sport Sci* 1978;3:61-64.

12 Hornoff Z, Napravnik C: Analysis of various accident rate factors for ice hockey. *Med Sci Sports* 1973;5:283-286.

13 Jorgensen U, Schmidt-Olsen S: The epidemiology of ice hockey injuries. *Br J Sports Med* 1986;20:7-9.

14 Lorentzon R, Wendron H, Pietila T, Gustavsson B: Injuries in international ice hockey: A prospective, comparative study of injury incidence and injury types in international and Swedish elite ice hockey. *Am J Sports Med* 1988;16:389-391.

15 Lorentzon R, Wendron H, Pietila T: Incidence, nature, and causes of ice hockey injuries: A three-year prospective study of a Swedish elite ice hockey team. *Am J Sports Med* 1988;16:392-396.

16 MacIntosh DL, Skrien T, Shephard RJ: Athletic injuries at the University of Toronto. *Med Sci Sports* 1971;3:195-199.

17 Meeuwisse WH, Fowler PJ: Frequency and predictability of sports injuries in intercollegiate athletes. *Can J Sport Sci* 1988;13:35-42.

18 McKnight CM, Ferrara MS, Czerwinska JM: Intercollegiate ice hockey injuries: a three year analysis. *J Athletic Training* 1992;27:338-343.

19 Millar W, Adams O: *Accidents in Canada.* Ottawa: Statistics Canada, 1991

20 Pashby TJ, Pashby RC, Chisholm LD, et al: Eye injuries in Canadian hockey. *Can Med Assoc J* 1975;113:663-666.

21 Pashby TJ: Eye injuries in Canadian amateur hockey. *Am J Sports Med* 1979;7:254-257.

22 Pashby TJ: Eye injuries in Canadian amateur hockey. *Can J Optham* 1985;20:2-4.

23 Pelletier RL, Montelpare WJ, Stark RM: Intercollegiate ice hockey injuries, a case for uniform definitions and reports. *Am J Sports Med* 1993;21:78-81.

24 Pollock JL, Wilmore JH: *Exercise in Health and Disease: Evaluation and Prescription for Prevention and Rehabilitation.* Philadelphia: WB Saunders Company, 1990.

25 Reeves JSH, Mendryk SW: A study of hockey injuries in the Greater Edmonton area. In: Taylor AW, ed. *Application of Science and Medicine to Sport.* Springfield: Thomas Publishing, 1975:301-308.

26 Regnier G, Boileau R, Marcotte G, et al. Effects of body-checking in the Pee-Wee (12 and 13 years old) Division in the province of Quebec. In: Castaldi CR , Hoerner EF, ed. *Safety in Ice Hockey.* Philadelphia: ASTM, 1989: 84-103.

27 Rielly MF: The nature and causes of hockey injuries: a five-year study. *Athletic Training* 1982;17:88-90.

28 Roy MA, Bernard D, Roy B, Marcotte G: Body checking in Pee Wee hockey. *Phys Sports Med* 1989;17:119-126.

29 Sim FH, Simonet WT, Melton LJ, Lehn TA: Ice hockey injuries. *Am J Sports Med* 1987;15:30-40.

30 Smith MD: Violence and injuries in ice hockey. *Clin J Sports Med* 1991;1:104-109.

31 Sports Medicine Council of Alberta. Unpublished data., 1993.

32 Sutherland GW: Fire on ice. *Am J Sports Med* 1976;4:264-269.

33 Tator CH, Edmonds VE: National survey of spinal injuries in hockey players. *Can Med Assoc J* 1984;130:875-880.

34 Tator CH: Neck injuries in ice hockey: a recent unsolved problem with many contributing factors. *Clinics Sports Med* 1987;6:101-114.

35 Tegner Y, Lorentzon R: Ice hockey injuries: incidence, nature and causes. *Br J Sports Med* 1991;25:87-89.

36 Thomson DH, Flint FA, McDonald E. *A LIterature Review of Information on Injuries Incurred During Sports , Fitness, and Recreation Activities.* Toronto: Ministry of Tourism and Recreation, 1989.

37 Toogood T, Love WG: Hockey injury survey. *J Can Assoc Health Phys Educ Recreat* 1966;32(2):20-23.

CHAPTER 2

ICE HOCKEY INJURIES TREATED IN TWO EMERGENCY DEPARTMENTS[1]

2.1 Introduction

The popularity of ice hockey in Canada cannot be denied. Ice hockey, however, is a contact/collision sport which puts participants at risk of injury usually due to some type of sudden trauma. This sudden trauma is commonly in the form of collisions with other players (incidental and body checks), the playing environment (boards, goals, and ice surface), or playing equipment (sticks and pucks). With the exception of Pelletier et al. (10), the use of emergency room data as source of information concerning the nature and frequency of ice hockey injuries in Canadian communities has been relatively untapped. In addition, the current literature examining ice hockey injuries pertains to special groups such as minor hockey (2,4,5,12) or international/elite hockey (6,8,9,15). There is little reported injury data concerning non-traditional study populations such as adult recreational or female ice hockey players.

The objectives of this study were three-fold. The first objective was to determine the injury rate for ice hockey for an entire year in a mixed urban/rural community. Secondly, to evaluate the nature (anatomic, diagnostic, and mechanistic distributions) of the reported injuries. Finally, to determine the frequency of injury by age, gender, and date/time of injury.

2.2 Method

The injury data for this study was provided by information collected using the Ontario Ministry of Health Emergency Patient Information System (EPIS) at both Kingston General (KGH) and Hotel Dieu (HDH) hospitals, which are the only two emergency departments offering service to the greater Kingston, Ontario region. The greater Kingston region is comprised of the city of Kingston plus several smaller communities and townships. The aggregate population is in excess of 100,000.

The EPIS collects information from patients who visit the emergency department for treatment. One of the pieces of information this system collects is the type of activity that a person was engaged in at the time of injury. These activities are coded using E-codes from the International Classification of Diseases. There is a specific code developed as a suffix to the main 917 E-code that allows for the coding of 26 sport activities. In addition, the diagnostic nature of the injury is also coded.

For the purposes of this study, an injury was defined as: *An acute injury that cccurred while playing ice hockey that required treatment by either of Kingston's acute care hospitals (KGH or HDH).*

Electronic data concerning ice hockey injuries from the EPIS in each hospital were down-loaded onto a single page report for each patient encounter onto which additional information was added manually from emergency

---

[1]A version of this chapter has been published. Voaklander DC, Brison RJ, Quinney HA, Macnab RB, Darko E 1994. Clinical Journal of Sports Medicine. 4:25-30.

department charts. Facility/league schedules and participant rosters were obtained from all persons, municipalities, organizations, and leagues involved in the scheduling of ice hockey. Responsible individuals were contacted by both mail and telephone until all information was complete. Data were collected for a full year, running from September 1, 1990 to August 31, 1991.

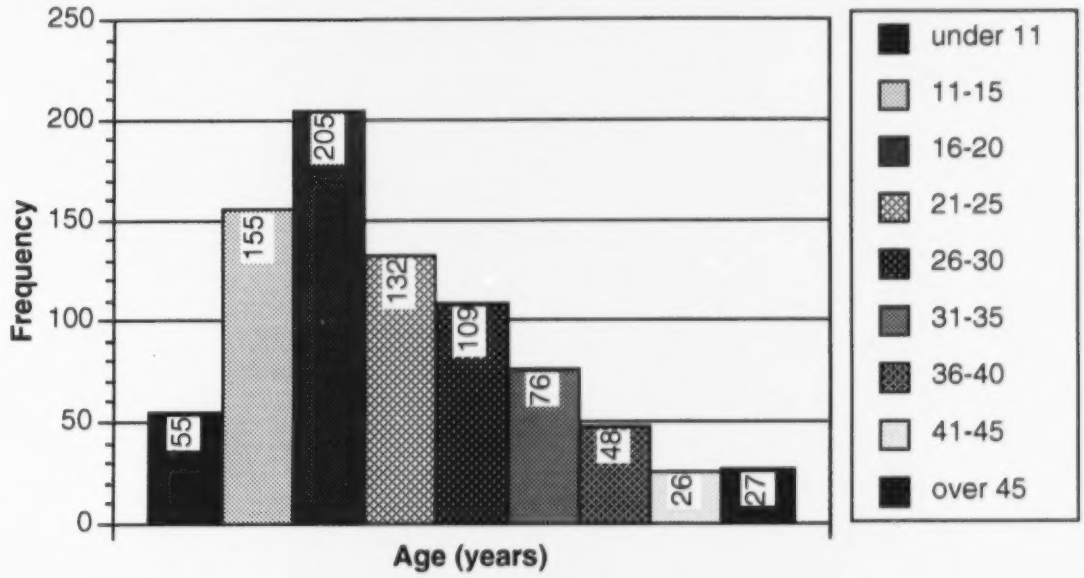
Where cell size permitted, statistical tests were performed using one-way ANOVA for continuous variables (Sheffe procedure). Incidence rates were calculated per registered participant and per registered participant-hour of exposure. The participant-hour denominator was determined by summing all player-exposure hours for a particular sport for both practices and games. Player-exposure for games was calculated by using the number of players on the playing surface during normal play. For example; an ice hockey game that is 1 hour long would give 12 player-hours of exposure. For practice exposure, the average number of players per team in a particular league was used. For example; a 1 hour practice in a league in which the average team size was 15 players would result in 15 player-hours of exposure.

2.3 Results

The numbers participating in ice hockey in the greater Kingston region were estimated at 4691 (133,559 participant-hours) for males and 224 (3782 participant-hours) for females. The total number of ice hockey injuries reported to the HDH and KGH emergency departments was 833 or 0.93% of all patient encounters over the data collection period. The injury rates for males were 168 injuries/1000 participants or 5.9 injuries/1000 participant-hours. The injury rates for females were 201 injuries/1000 participants or 11.9 injuries/1000 participant-hours. Fifty four males and 3 females were referred to other health care services (eg. orthopedics, opthamology, plastics, dental, etc.) for further treatment. Fourteen male hockey players were also admitted to hospital as a result of injuries. Seven of the hospital admissions were due to injuries to the head/neck/facial area, 3 were to the torso, 3 were to the lower extremity, and 1 was to the upper extremity.

The mean age of males and females reporting injuries was respectively, 23.8±10.3 and 18.2±7.7 years. The age distribution of injured persons is shown in Figure 2-1.

Figure 2-1
Age distribution of persons reporting injuries



The bulk of injuries (75%) were reported between noon and midnight. Injuries were found to be evenly distributed throughout the week. Almost half of the injuries (48%), however, were reported to the emergency department at least 1 day after the injury occurred (Table 2-1). Injuries were, for the most part, evenly distributed throughout the hockey season, although January, February, and March showed a slightly higher incidence than October, November, and December.

Both males and females were most often injured in collisions (excluding body checks), 25% and 22% of all injuries respectively. The lower extremity was the predominant anatomical area injured (male, 25%; female, 38% of all injuries). Bruises were diagnosed most often (male, 40%; female, 51% of all injuries). Tables 2-2 through 2-4 illustrate the anatomic, diagnostic, and mechanistic distributions of injuries for males. Figures 2-2 and 2-3 detail the distribution of upper and lower extremity injuries for both males and females.

Figure 2-2
Distribution of lower extremity injuries for males and females

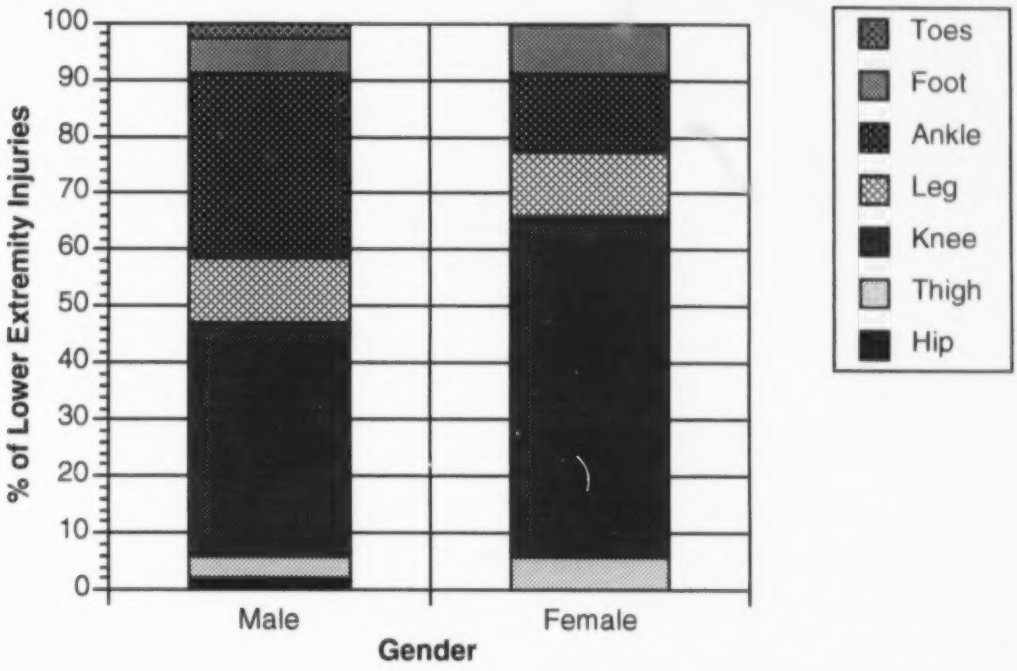


Table 2-1
When treatment was sought following injury

	Diagnosis						
	Fracture	Dislocation	Strain /Sprain	Laceration	Bruise	Concussion	All Diagnoses[1]
The Same Day	48(61%)	7(58%)	50(38%)	127(87%)	110(38%)	14(78%)	356(52%)
The Next Day	20(25%)	2(17%)	51(39%)	11(8%)	110(38%)	3(17%)	197(29%)
Later	11(14%)	3(25%)	31(23%)	8(5%)	68(24%)	1(5%)	134(19%)

[1]Note: this data was available for 647 subjects (83%).

Table 2-2
Anatomical distribution of injury mechanisms (male)

	Anatomical Site						
Mechanism	Head/Neck	Face	Eye	Upper Extremity	Torso	Lower Extremity	Total
Unknown	5(13%)	11(6%)	0(0%)	23(12%)	15(11%)	21(11%)	74(9%)
Fighting	1(3%)	12(6%)	0(0%)	7(3%)	0(0%)	0(0%)	20(3%)
No Contact	3(8%)	0(0%)	0(0%)	1(<1%)	7(4%)	49(25%)	60(8%)
Falls	7(18%)	5(3%)	0(0%)	32(17%)	13(8%)	5(3%)	62(8%)
Body Checks	6(15%)	8(4%)	1(6%)	31(16%)	58(37%)	18(9%)	122(16%)
Puck Contact	4(10%)	45(24%)	6(38%)	17(9%)	7(5%)	45(23%)	124(16%)
Stick Contact	6(15%)	72(38%)	9(56%)	25(13%)	13(8%)	8(4%)	133(17%)
Collisions	7(18%)	37(19%)	0(0%)	57(30%)	42(27%)	49(25%)	192(25%)
Total	39(100%)	190(100%)	16(100%)	193(100%)	155(100%)	195(100%)	788(100%)

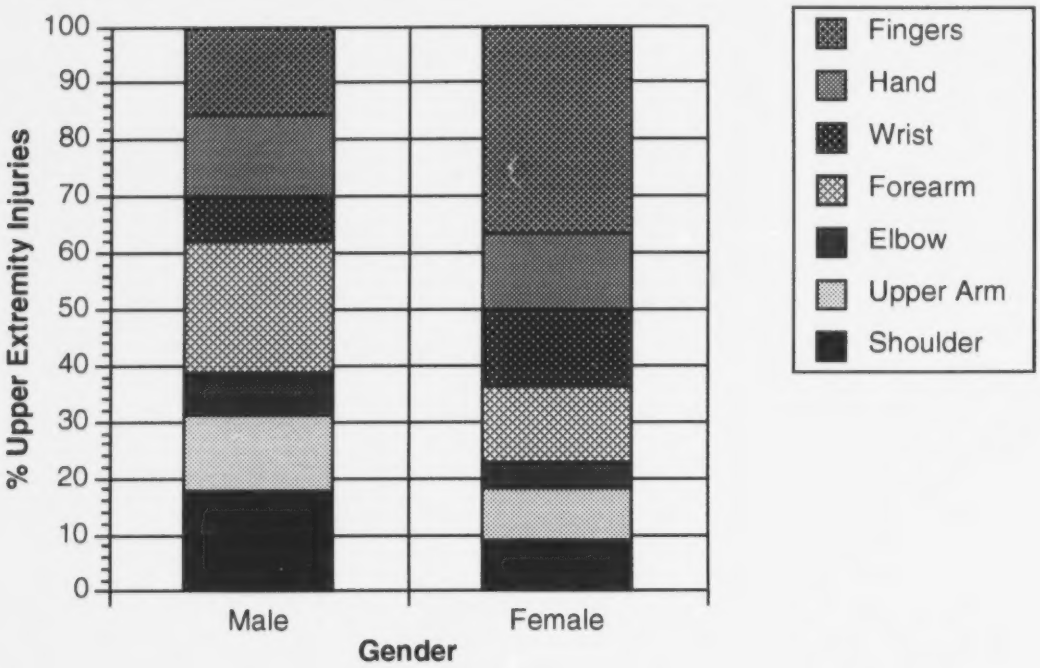
Table 2-3
Diagnostic distribution of injury mechanisms (male)

Injury Mechanism	Diagnosis						
	Fracture	Dislocation	Sprain/ Strain	Laceration	Bruise	Concussion	Total
Unknown	13(11%)	1(8%)	22(15%)	10(6%)	28(9%)	1(6%)	74(9%)
Fighting	3(3%)	0(0%)	0(0%)	10(6%)	7(2%)	0(0%)	20(3%)
No Contact	4(4%)	0(0%)	37(24%)	0(0%)	19(6%)	0(0%)	60(8%)
Falls	11(9%)	6(46%)	13(9%)	8(4%)	18(6%)	6(35%)	62(8%)
Body Checks	16(14%)	1(8%)	36(24%)	4(2%)	61(20%)	4(24%)	122(15%)
Puck Contact	17(15%)	0(0%)	4(3%)	45(25%)	57(18%)	1(6%)	124(16%)
Stick Contact	12(10%)	0(0%)	2(1%)	76(42%)	42(13%)	1(6%)	133(17%)
Collisions	40(34%)	5(38%)	37(24%)	26(15%)	80(26%)	4(24%)	192(24%)
Total	116(%)	13(100%)	151(100%)	179(100%)	312(100%)	17(100%)	788(100%)

Table 2-4
Anatomical distribution of injury diagnoses (male)

Anatomical Site	Diagnosis						
	Fracture	Dislocation	Sprain/ Strain	Laceration	Bruise	Concussion	Total
Head/Neck	6(5%)	0(0%)	7(5%)	9(5%)	0(0%)	17(100%)	39(5%)
Face	15(13%)	0(0%)	7(5%)	141(79%)	27(9%)		190(24%)
Eye	0(0%)	0(0%)	0(0%)	9(5%)	7(2%)		16(2%)
Upper Extremity	47(41%)	13(100%)	7(5%)	16(9%)	110(61%		193(24%)
Torso	22(19%)	0(0%)	67(44%)	2(1%)	64(21%)		155(20%)
Lower Extremity	26(22%)	0(0%)	63(42%)	2(1%)	104(33%)		195(25%)
Total	116(100%)	13(100%)	151(100%)	179(100%)	312(100%)	17(100%)	788(100%)

Figure 2-3
Distribution of upper extremity injuries for males and females



The age of males reporting fractures (23.0±11.4 years) and bruises (22.2±9.8 years) were significantly ($p \leq .05$) younger than males afflicted by lacerations (24.6±10.9 years) or dislocations (30.0±7.9 years). The age of males suffering injury as a result of being struck by a puck (28.1±10.9 years) was significantly ($p \leq .05$) older than males who reported other injury mechanisms [range: 19.7±4.8 (fighting) to 23.5±10.4 (collisions) years].

2.4 Discussion

The present study relies on the exclusive use of emergency department records for the numerator portion of the reported injury rates. Injured persons who were treated by alternate health care facilities such as walk-in clinics, family physicians, first aid stations, etc., or that sought no treatment are not included. The fact that 48% of the injuries were treated at least 1 day following the injury indicates that many individuals may have had sufficient time to consider alternatives to being treated in the emergency department. Although, no comparable Canadian statistics exist, de Loës (3) found that 24% of all acute sports injuries that occurred in a Swedish community of 34,000 were treated by private practitioners. If a similar situation existed in Kingston, the effect would be the underestimation of the true injury rates (per participant, or participant-hour).

Another source of error that may effect the estimation of the participant and participant-hour injury rates comes from the calculation of the exposure denominator. The data used to calculate the denominator portion of the injury rates comes from only organized teams and leagues in the Kingston area. The

lack of information about ad-hoc involvement in ice hockey causes an overestimation of the injury rates because the exposure denominator is smaller than what is actually present. Ice hockey participation, however, is limited by the accessibility of facilities, therefore, estimation error would be much lower than for sports such as soccer or football. Unfortunately, there is no way to determine what the cumulative effect of these numerator and denominator inaccuracies are, with respect to the calculation of the participant and participant-hour injury rates as they are presented. Additionally, no specific information was available from the emergency department charts regarding whether injuries occurred during games or practices. This precluded the calculation of separate practice and game injury rates.

The female injury rate (participant-hour) was approximately double the male rate. This is surprising, considering that female leagues do not allow body checking. The relatively small sample of female injuries (n=45) precludes a statistically meaningful comparison to the male injury pattern. However, females reported no eye injuries and proportionately fewer facial injuries than their male counterparts. This is most likely due to mandatory facial protection in female leagues. More research is required to determine the female ice hockey injury pattern.

The anatomic, diagnostic, and mechanistic distributions of injury observed for males in this research falls into line with ice hockey injury research that has been conducted since the use of facial protection became wide spread throughout most levels of play (2,4,5,7,8,9,12,15). It is worth noting, though, that the age of male ice hockey players reporting lacerations was significantly elevated (24.6±10.9 years). The bulk of the lacerations reported by male ice hockey players were to the face (79%). Because it is not a requirement in senior levels of recreational hockey to wear full or partial facial protection, it is likely that players at these levels of play are at greater risk of facial injury. Mechanistically, the age of males suffering injuries from being struck by the puck was significantly greater than the other injury mechanism categories. The mean age of individuals treated for facial lacerations caused by pucks was 30.1±9.7 years. Errant pucks would appear to be a major threat to players with unprotected faces. The age of players reporting eye and facial injuries that required referrals (30% of all referrals) to further health services was also elevated (26.7±9.9 years). These statistics indicate that facial protection remains an important determinant of the nature of trauma suffered by ice hockey players. Only 1 facial injury to a player in a league where full facial protection is mandatory (peewee level) required a referral for further medical treatment. Data on the average age of catastrophic eye injuries reported by Pashby (11) reflects the age distribution of facial and eye injuries reported in the present research.

The age of males diagnosed as having dislocations was also significantly elevated (30.0±7.9 years). Of the 13 dislocations (12 glenohumeral and 1 metacarpal) diagnosed for male ice hockey players, 6 glenohumeral dislocations were caused by falls to the ice surface. This may indicate that as skill levels and fitness decline with age, older players may be at a greater risk of shoulder dislocation. Falls on outstretched arms are a major cause of shoulder dislocation (1).

The amount of time that elapsed between injury and treatment for fractures, dislocations, bruises, and strains/sprains indicates that a large number

of individuals suffering these types of injuries do not seek treatment the same day the injury occurred. Many of these injuries would have required immobilization, medication, appropriate modalities, etc. Players reporting them the same day certainly could have benefited from early diagnosis and treatment. A survey of sports medicine clinic clientele found a similar pattern of hesitant treatment seeking by injured athletes (6). Another clinic reported that only 1/3 of their patients were treated within the first week of injury (13). Survey responses indicated that many athletes tended to disregard important injury symptoms and possessed only superficial knowledge of the signs of serious injury (6). A conservative estimate of the number of athletes in this study under the supervision of coaches would be 60% to 70%. Hockey coaches in Ontario (or Canada) are not required to be certified in any type of first aid or emergency care methods. Certainly some knowledge of injury identification would be helpful to coaches, but as this is not generally the case, league policy should dictate that coaches (and referees) encourage injured players to seek medical attention when an injury is suspected.

2.5 Conclusions

The information presented in this research quantifies the frequency and nature (diagnostic pattern, anatomic distribution, and mechanism) of injuries in ice hockey reported to 2 emergency departments. Injury rates were calculated ecologically from participation data. No individual participation data or characteristics (other than gender and age) were linked to specific injuries.

The data obtained from emergency room records surpassed our expectations with regard to accuracy and completeness. While only ice hockey was presented in the present research, the potential to analyze data for a wider variety of sport and recreation activities from emergency department records would seem to be high. It has been commented that the general lack of sport and recreation injury data would be enhanced by systematic auditing of emergency department records (14).

Recommendations from the present research address three specific areas. The first is facial protection. The data indicate that while younger players are well protected from potentially catastrophic eye and disfiguring facial injuries, many adult players are not. Facial protection should be mandatory for all adult male hockey players.

The second recommendation concerns the length of time between injury and treatment. Hockey associations and leagues at all levels should encourage coaches, referees, and league officials to become knowledgeable about the nature of injuries. Players should also be encouraged to seek medical treatment as soon as possible after an injury occurs.

And finally, more injury research should be conducted with women's ice hockey. Hockey is a sport that is growing in popularity with females. The frequency and nature of injuries in this population should be monitored to determine any measures that would reduce the chance of injury.

2.6 References

1 Arnheim DD: *Modern Principles of Athletic Training*. St. Louis: CV Mosby Company, 1985.

2 Brust JD, Leonard BJ, Pheley A, Roberts WO: Children's ice hockey injuries. *A J Dis Child* 1992;146:741-747.

3 de Löes M, Goldie I: Incidence rate of injuries during sport activity and physical exercise in a rural Swedish municipality: Incidence rates in 17 sports. *Int J Sports Med* 1988;9:461-467.

4 Finke RC, Gerberich SG, Madden M, Funk S, Murray K, Priest D, Aamoth GM: Shoulder injuries in ice hockey. *J Ortho Sports Phys Ther* 1988;10:54-59.

5 Gerberich SG, Finke R, Madden M, Priest JD, Aamoth G, Murray K: An epidemiological study of high school ice hockey injuries. *Child's Nerv Syst* 1987;3:59-64.

6 Kent, F: Athletes wait too long to report injuries. *Physician Sportsmed* 1982;10:127-129.

7 Jorgensen U, Schmidt-Olsen S: The epidemiology of ice hockey injuries. *Br J Sports Med* 1986;20:7-9.

8 Lorentzon R, Wendron H, Pietila T, Gustavsson B: Injuries in international ice hockey: A prospective, comparative study of injury incidence and injury types in international and Swedish elite ice hockey. *Am J Sports Med* 1988;16:389-391.

9 Lorentzon R, Wendron H, Pietila T: Incidence, nature, and causes of ice hockey injuries: A three-year prospective study of a Swedish elite ice hockey team. *Am J Sports Med* 1988;16:392-396.

10 Pelletier RL, Anderson G, Stark RM: Profile of sport/leisure injuries treated at emergency rooms of urban hospitals. *Can J Sport Sci* 1991;16:99-102.

11 Pashby, TJ: Eye injuries in Canadian Amateur Hockey. *Can J Optham* 1985;20:2-4.

12 Regnier G, Boileau R, Marcotte G, et al. Effects of body-checking in the Pee-Wee (12 and 13 years old) Division in the province of Quebec. In: Castaldi CR , Hoerner EF, ed. *Safety in Ice Hockey.* Philadelphia: ASTM, 1989: 84-103.

13 Reid DC: *Sports Injury Assessment and Rehabilitation.* New York: Churchill Livingstone, 1992.

14 Saunders LD, Stewart LM, eds: *A Safer Canada - Year 2000 Injury Control Objectives for Canada.* Edmonton: Injury Awareness and Prevention Centre, University of Alberta Hosptitals, 1991.

15 Tegner Y, Lorentzon R: Ice hockey injuries: incidence, nature and causes. *Br J Sports Med* 1991;25:87-89.

CHAPTER 3

THE EPIDEMIOLOGY OF RECREATIONAL AND OLD-TIMER ICE HOCKEY INJURIES[1]

3.1 Introduction

The rise in popularity of adult recreational ice hockey mandates that efforts be made to ensure the safety of participants. While an estimate of numbers involved is illusive, one study found that approximately 37% of all hockey ice time in Ontario was used by adult recreational hockey players (6). Almost all of what we know about the incidence and nature of ice hockey injuries is from studies that have not examined adult recreational populations (1,5,8-10,13-15,17,18,22-24).

Many recreational hockey leagues have prohibited intentional body contact and in the case of old-timer leagues, have prohibited the slap shot. It is important to examine the mechanistic, diagnostic, and anatomic distribution of injuries observed in leagues that have instituted these rule modifications. Additionally, recent information suggests there is a rise in the number of catastrophic eye injuries suffered among adult recreational hockey players (3). If this is the case, a quantitative analysis of facial injuries as well as the facial protection worn is suggested for recreational hockey players. The present research examines the nature and incidence of injuries suffered by a sample of recreational and old-timer hockey players.

3.2 Methods

Subjects for this research were recruited from hockey leagues operating within the Greater Edmonton area. Administrators in eight leagues with a total of 154 teams were contacted 1 year prior to the start of the study. These leagues represented approximately 80% of the adult recreational ice hockey in the Greater Edmonton area. Loose affiliations of individual teams that share ice time for games and female hockey leagues were not contacted. In addition, a league operating in Strathcona County adjacent to Edmonton was over-looked during the initiation of this research. Confirmation of league participation was obtained in the 2 to 3 month period immediately prior to the start of the 92/93 hockey season. Adult male recreational leagues (AMRL) include players age 18 years and up. The AMRL leagues are similar to traditional ice hockey with one major exception, intentional body contact is against the rules. Teams in this category were selected by proportional random sampling of the participating leagues with a minimum of 2 teams selected from each league until the desired sample size was reached. Old timer leagues (OTL) are basically comprised of players aged 30 years and over, however league rules usually allow 1 to 2 players on a team to be under this age. The OTL leagues, in addition to the prohibition of intentional body contact, also do not allow the use of the slap shot. All available old timer teams in the participating leagues were sampled to maximize the sample size.

---

[1]A version of this chapter has been submitted to the American Journal of Sports Medicine.

Players were recruited in the dressing room prior to the start of a team's first game of the 1992-93 hockey season. Injury and game/practice attendance data were collected at the end of each calendar month for the duration of the hockey season (including playoffs) by a telephone interview while diagnostic information for individuals who sought medical treatment was solicited from the attending health professional/institution. Informed consent was received from each study participant.

For the purposes of this study an injury is defined as:

> *Any acute injury sustained while playing recreational hockey during any practice or game that results in an individual missing the remainder of a game/practice, a subsequent game/practice, and/or that requires an individual to consult a health professional.*

The raw data were entered into a micro-computer and was subsequently transferred to the University of Alberta mainframe computer (MTS) for analysis. Data analyses were performed using SPSS statistical software(18).

Differences between the OTL, AMRL, and non-participating populations were compared using chi-square and student's t-test statistics. Incidence rates were calculated per player and per player-exposure. The player-exposure rate was calculated using the following equation: *Rate = number of injuries/Σ(reported game/practice attendance for each player).* Frequency tables were also generated to illustrate the diagnostic, anatomic, and mechanistic distributions of injury. Differences between the OTL and AMRL patterns of injury were tested using the chi-square statistic. The injury sample size allowed for the detection of a medium effect (4) for OTL and AMRL comparisons. Differences in the number of days of work missed as result of injury between AMRL and OTL were tested using the Mann-Whitney U test. The significance level for bivariate statistical procedures was established as $p \leq .05$.

3.3 Results

Officials from 5 of the 8 leagues asked to participate gave their permission for players to be approached to participate in this study. Five hundred hockey players from 41 teams in these 5 leagues were then asked to participate in this project. Of these, 46 refused to consent to be subjects (27 of these did fill out a demographic questionnaire) and a further 23 subjects were lost to follow-up before any injury or participation data could be collected from them. The final study sample consisted of 431 subjects (287 AMRL and 144 OTL players) or 86% of those initially asked to participate (87% for AMRL and 83% for OTL). As the hockey season progressed, a further 4 players moved out of Edmonton, 3 players quit hockey, 17 players had phones disconnected for which new numbers could not be found, and 4 players stopped responding to messages left on their answering machines. Partial data for these players were included in these results.

The demographic characteristics of study subjects are illustrated in Table 3-1. AMRL players were significantly younger, reported a lower frequency of alcohol use, were more likely to be students or occupationally unskilled, and were

less likely to be married than OTL players. Those not participating in the study were more likely to be tobacco users.

Table 3-1
Subject demographics*

Variable	AMRL (n=287) mean±SD/%	OTL (n=144) mean±SD/%	Non-Responders (n=27) mean±SD/%	Lost to Follow-up (n=23) mean±SD/%
Age (years)[1]	28.9±5.5	34.5±4.8	31.9±6.0	30.3±4.9
Weight (kg)	81.0±9.6	82.4±8.4	81.0±11.8	82.7±11.7
Height (m)	1.79±0.06	1.79±0.06	1.78±0.05	1.78±0.08
BMI (kg/m^2)	25.4±2.7	25.7±2.6	25.6±3.2	25.9±2.4
Married[2]	55.1%	78.5%	74.1%	47.8%
Smoker[3]	11.5%	14.6%	44.4%	17.4%
Alcohol Use[4]				
<Once/Week	31.9%	19.6%	22.2%	17.4%
1-3 Times/Week	59.4%	57.3%	51.9%	73.9%
>3 Times/Week	8.7%	23.1%	25.9%	8.7%
Occupation[5]				
Unskilled	10.2%	4.2%	11.5%	14.3%
Trades	15.3%	17.9%	23.1%	9.5%
Manager	11.5%	13.6%	11.5%	
Student	8.5%		7.1%	
Professional	54.6%	64.3%	46.2%	76.2%
Injured in Past Year	39.9%	43.8%	29.6%	31.8%
Participates in Other Fitness Activities	76.6%	76.7%	55.6%	95.2%

*Non-responders were grouped with those lost to follow-up for statistical comparison with study subjects.
[1]p<.001; t=-11.2; AMRL and OTL compared
[2]p<.001;chi-square=23.0; AMRL and OTL compared
[3]p<.001; chi-square=14.0; Lost from study sample and study sample compared
[4]p<.001; chi-square=18.7; AMRL and OTL compared
[5]p<.001;chi-square=19.5; AMRL and OTL compared

A total of 151 injuries were reported during the 1992/93 hockey season. The aggregate injury rate was calculated to be 350 injuries/1000 players (95%CI;305,395) or 12.2 injuries/1000 player-exposures. Eighty-seven AMRL players reported 100 injuries during the study period. This gives injury rates of 348 injuries/1000 players (95%CI;294,402) or 12.3 injuries/1000 player-exposures. Forty-four OTL players reported 51 injuries during the study period.

This gives injury rates of 354 injuries/1000 players (95%CI;276,432) or 12.0 injuries/1000 player exposures.

Overall, the lower extremity was the injury site most often reported (34%). The anatomic region most often injured for AMRL players was the head/neck/facial area (32%). The anatomical region most often injured for OTL players was the lower extremity (40%). No significant differences were detected in the anatomic distribution of injury between AMRL and OTL players (See Table 3-2). Figures 3-1, 3-3, and 3-5 illustrate in detail the anatomic distributions of injury for AMRL players while Figures 3-2, 3-4, and 3-6 detail the same information for OTL players. While there appears in these graphs some differences in the detailed anatomic distribution of injury (eg. a higher proportion of knee injuries among OTL players), the cell sizes are too small for meaningful comparison. For the aggregated sample, 3% of players wearing full or half face protectors suffered facial injuries while 9% of players not wearing any facial protection reported facial injuries (p=.03).

Table 3-2
Anatomic distribution of injury†

Anatomical Site	AMRL	OTL	Total
Head/Neck/Face	32(32%)	13(25%)	45(30%)
Upper Extremity	23(23%)	13(25%)	36(24%)
Torso	14(14%)	5(10%)	19(12%)
Lower Extremity	31(31%)	20(40%)	51(34%)
Total	100(100%)	51(100%)	151(100%)

†Comparison of anatomic distribution between AMRL and OTL (p=.79;chi-square=1.9)

Figure 3-1
Distribution of head/neck/face injuries (AMRL) (n=32)

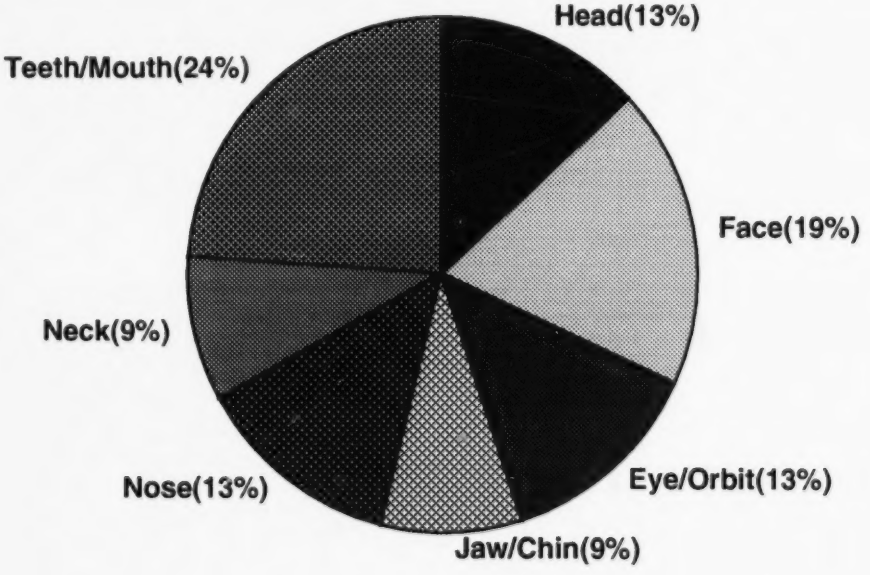


Figure 3-2
Distribution of head/neck/face injuries (OTL) (n=13)

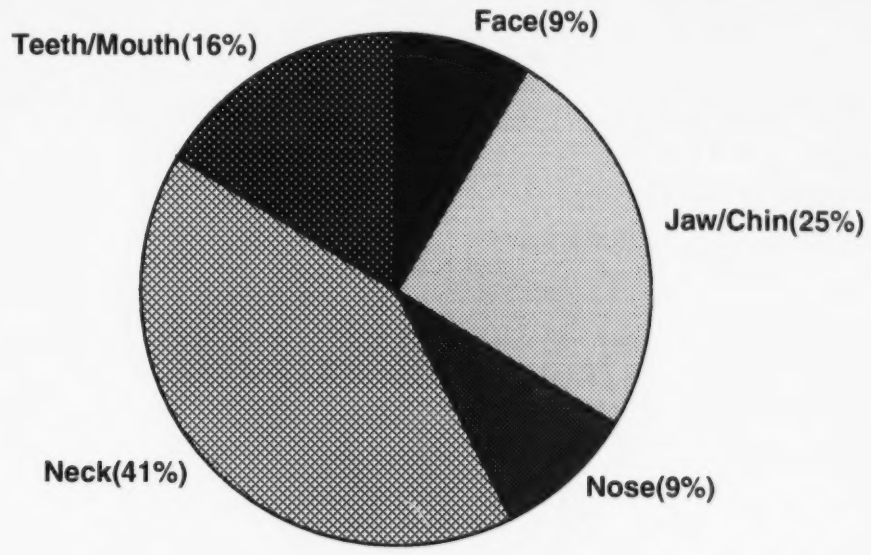


Figure 3-3
Distribution of upper extremity injuries (AMRL) (n=23)

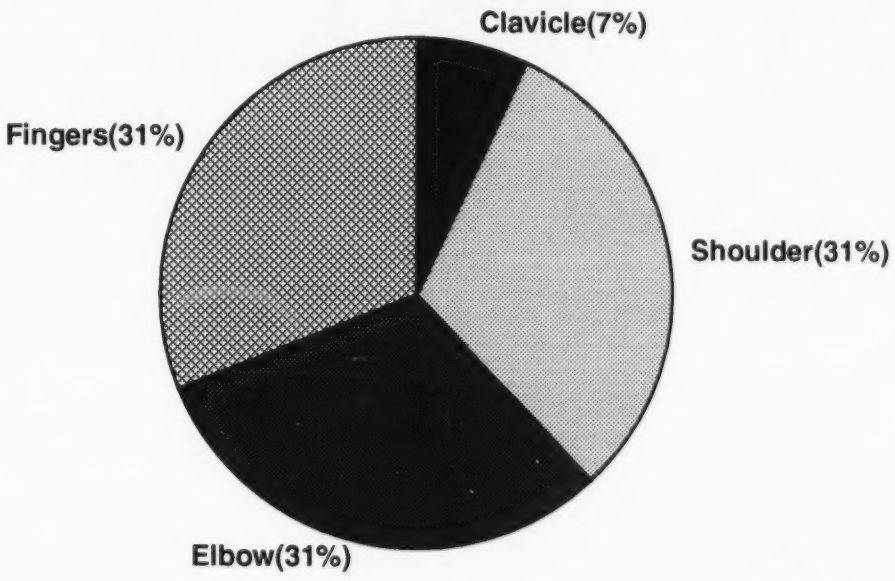


Figure 3-4
Distribution of upper extremity injuries (OTL) (n=13)

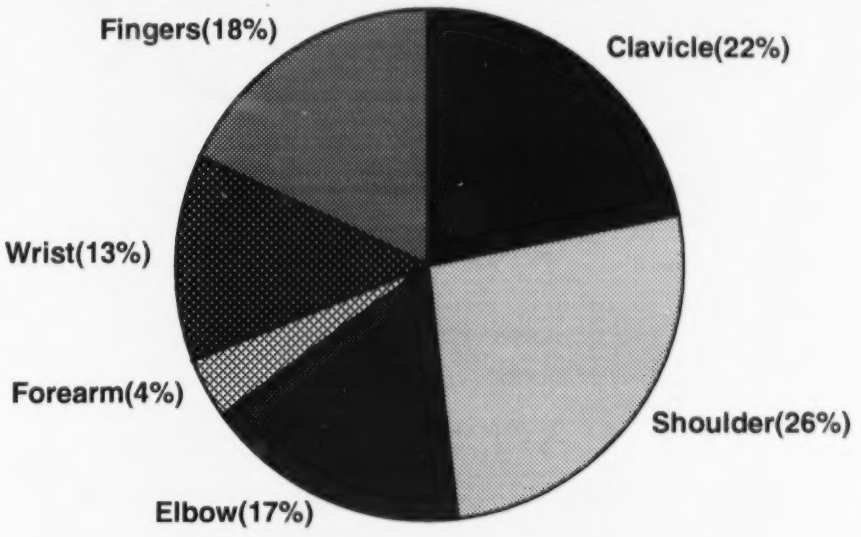


Figure 3-5
Distribution of lower extremity injuries (AMRL) (n=31)

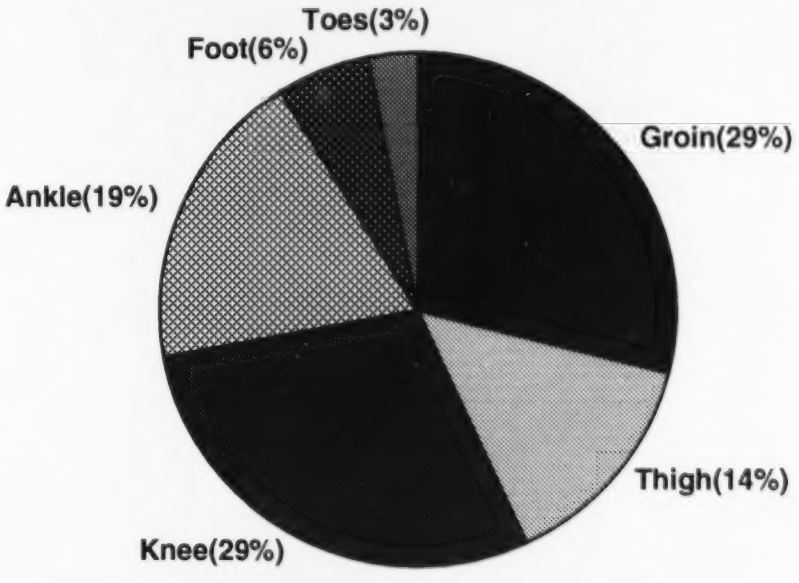
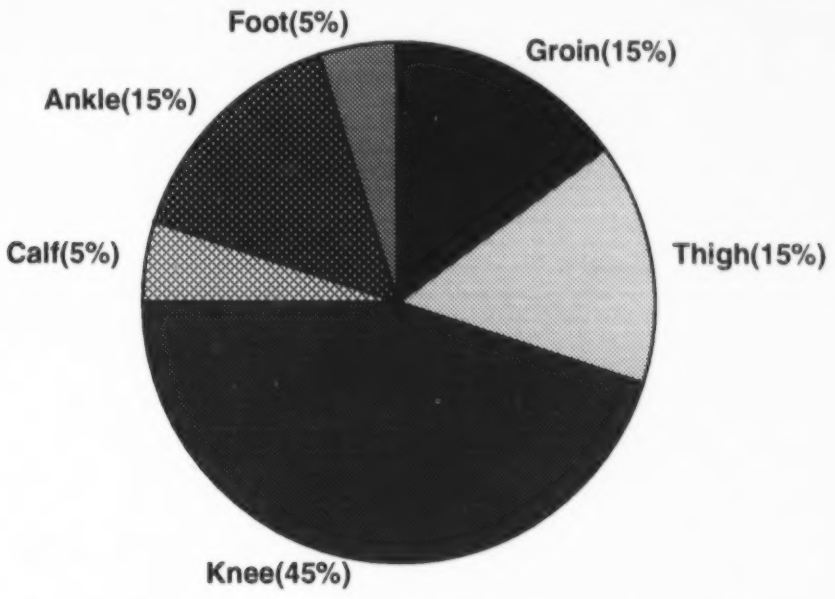


Figure 3-6
Distribution of lower extremity injuries (OTL) (n=20)



Sprains/strains[2] were the injury diagnosis most often reported for all players (39%). The predominant injury diagnosis for AMRL players was strains/sprains (35%). The predominant injury diagnosis for OTL players was also sprains/strains (47%). No significant differences were detected in the diagnostic distribution of injury between AMRL and OTL players (See Table 3-3). Facial lacerations accounted for 74% of all lacerations reported.

Table 3-3
Diagnostic distribution of injury*†

Diagnosis	AMRL	OTL	Total
Fracture	8(8%)	5(9%)	13(9%)
Dislocation	3(3%)	1(2%)	4(2%)
Sprain/Strain	35(35%)	24(47%)	59(39%)
Laceration	28(28%)	8(16%)	36(24%)
Bruise	26(26%)	12(24%)	38(25%)
Other	1(1%)	1(2%)	2(1%)
Total	100(100%)	51(100%)	151(100%)

*For statistical comparison the "other" category was deleted and dislocations were grouped with fractures.

†Comparison of diagnostic distribution between AMRL and OTL (p=.33;chi-square=3.4)

[2]While it is understood by the author that strains and sprains are distinct injury types, the decision was made to group the two categories due to error on self diagnosis as well as physician charting. It is unfortunate that two distinct injury categories have such similar names that they are often confused.

Overall, no dominant injury mechanism was reported with body checks, puck contact, stick contact, and collisions accounting for similar numbers of injuries (Table 3-4). The predominant injury mechanism for AMRL players was stick contact (24%). The predominant injury mechanism for OTL players was puck contact (23%), even though slapshots are penalizable in the OTL divisions. No significant differences were detected in the mechanistic distribution of injury between AMRL and OTL players.

Table 3-4
Mechanisms of injury*†

Mechanism	AMRL	OTL	Total
Fighting	1(1%)	0(0%)	1(1%)
No Contact	12(12%)	9(18%)	21(14%)
Falls	2(2%)	2(4%)	4(2%)
Body Checks	22(22%)	8(16%)	30(20%)
Puck Contact	18(18%)	12(23%)	30(20%)
Stick Contact	24(24%)	11(21%)	35(23%)
Collisions	21(21%)	9(18%)	30(20%)
Total	100(100%)	51(100%)	151(100%)

*For statistical comparison the fighting category was deleted and falls were grouped with collisions.
†Comparison of mechanistic distribution between AMRL and OTL (p=.59;chi-square=1.7)

Seventy-five percent of injuries occurred during league games (12.2 injuries/1000 player-exposures), 10% during playoff games (14.5 injuries/1000 player-exposures), 5% during tournament games (7.2 injuries/1000 player-exposures), and 10% during practices (15.1 injuries/1000 player-exposures). Twenty-eight percent of game injuries occurred during the first period, 36% during the second period, 33% during the third period, and 3% occurred during the pre-game warm-up. Penalties were assessed in 31% of injury instances.

Thirty-six percent of injuries were treated at hospital emergency departments while forty-four percent of injured players received medical care from community physicians. The remainder, 20%, did not seek medical attention for their injuries. Table 3-5 portrays the diagnostic distribution of injuries treated at the different venues. The response rate for diagnostic confirmation by physicians/hospitals was 79%. The diagnosis reported by players was in agreement with the physician/hospital abstract 83% of the time. Six players were hospitalized as a result of their injuries: 1 for a cervical spine fracture, 1 for acromio-clavicular joint separation/clavicle fracture, 1 for anterior cruciate/medial collateral ligament damage, 1 for a lacerated elbow which became infected, 1 for a fractured tibia, and 1 for a temporal-mandibular joint sprain. Seven players were referred to physical therapists, 7 to orthopedic specialists, 2 were referred to neurosurgeons, and 1 player was placed in the care of a neurologist.

Table 3-5
Where players sought treatment

Institution of Initial Treatment	Diagnosis: Fracture	Dislocation	Sprain/ Strain	Laceration	Bruise	Other	Total
No Treatment	0(0%)	2(50%)	19(32%)	2(5%)	7(19%)	1(50%)	30(20%)
Doctor's Office	3(23%)	1(25%)	34(58%)	6(17%)	21(57%)	1(50%)	67(44%)
Emergency Dept.	10(77%)	1(25%)	6(10%)	28(78%)	9(24%)	0(0%)	54(36%)
Total	13(100%)	4(100%)	59(100%)	36(100%)	37(100%)	2(100%)	151(100%)

Sixty-six percent of injuries resulted in an absence from hockey of 7 days or less, 22% required an absence of 8 to 28 days, and 12% required an absence of more than 28 days. Table 3-6 illustrates time lost from hockey by league type. The mean number days missed from work as a result of injury for AMRL players was 1.4±6.0 and 2.0±12.3 for OTL players. Eighty-four percent of injuries did not result in work time being lost.

Table 3-6
Injury severity as a function of time lost from hockey.†

Time Lost	AMRL	OTL	Total
Less than 7 days missed	66(66%)	34(67%)	100(66%)
8 to 28 days missed	24(24%)	9(17%)	33(22%)
More than 28 days missed	10(10%)	8(16%)	18(12%)

†Comparison between AMRL and OTL on severity (p=.11;chi-square=1.5)

3.4 Discussion

Ice hockey is a collision/contact sport that can be hazardous to participants. While considerable injury research has examined minor (1,5,8,18-22,24) and elite leagues (9,11,13-15,17,22,23), relatively few studies have included adult recreational players (12,17,25). It was the purpose of the present research to focus on the adult recreational player. Two types of leagues were examined, adult male recreational leagues (AMRL) and old-timers leagues (OTL). In both of these league types, body-checking is a penalizable activity, while the use of the slapshot is also prohibited in old-timer leagues.

Past hockey injury research studies have relied on record audits from various sources such as hospital emergency rooms (25), insurance claims (12,24), team physicians/trainers/coaches (9,10,14,15,17,22,23), direct observation (1,19,20) and player/coach/physician surveys (5,13,19,20). None of these particular methods, however, were felt to be practical with an adult recreational population. This was for several reasons. The first is that to calculate the incidence rate, the population at risk must be clearly defined and quantified. This precluded the use of emergency department or insurance records. Secondly, recreational hockey teams do not have team physicians, very few have trainers, and most do not have coaches. This eliminated the use of these individuals as data sources. Thirdly, personal observation was felt to be prohibitively expensive and time consuming considering the sample size involved. And finally, retrospective surveys conducted at the end of the season were felt to be too prone to recall bias, particularly for individuals who may have had multiple injury occurrences during a single season. Thus, a monthly

telephone interview combined with a diagnostic corroboration from the medical professionals that players consulted was the method used to obtain injury data. This strategy met the study's needs handily. Not only did the telephone interview capture a wealth of useful information, the abstract form sent to physicians and hospitals was also responded to with more enthusiasm than we had expected. In 79% of cases, a diagnostic abstract was obtained where an injured player had consulted with or received treatment from a medical professional.

It is interesting to note that the only significant difference between the study subjects and those not participating or lost to follow-up was in the proportion of smokers. It is not clear from the information available why smokers would decline to be participants, however, it may relate to further non-conformist behavior as smokers are a clear minority in this population. Other research has found smoking to be a risk factor related to traumatic events such as suicide (11) and motor vehicle accidents (2). Additionally, smokers tend to exhibit high risk behaviors such as reduced seat belt usage (7).

Virtually identical injury rates were observed for AMRL and OTL. Injury rate comparisons with previous investigations are difficult due to the differences in injury definition and denominator selection. Additionally, little injury data exists with regard to recreational players, thus comparisons are limited to adult major/elite populations. These short comings aside, it appears that the injury rates observed in the present research are lower than what has been observed in studies of adult major/elite players with comparable injury definitions and exposure denominators (14,15,17,23). This is not surprising considering the lower intensity level of the competition, slower speeds, and rule modifications in use among the present study population.

There was no significant difference found between AMRL and OTL players regarding the anatomical distribution of injury over broad anatomic categories. While some differences between AMRL and OTL players were observed when the anatomic distribution is broken down further (Figures 3-1 through 3-6), the small cell sizes defy statistical comparison. However, the OTL players appear to suffer more neck and knee injuries than their AMRL counterparts. Anatomically over both groups, the most common injury region in the present research was the lower extremity (34% of all injuries). The lower extremity was also found to be the most common injury area among Canadian varsity (17) and Swedish elite (15) players. Similarly, the knee was the most common lower extremity injury site. Previous injury research has also found the head/neck/facial area to have a high injury incidence (1,10,12-18,22-25). As 30% of all injuries were to the head/neck/facial area, the present research appears to be concordant.

Diagnostically over both strata, there is consistency with previous research that has found that sprains/strains/dislocations are most often reported (17,23). The proportion of lacerations reported (24%) in the present research is also consistent with leagues in which facial protection is optional (15,23). However, it is higher than leagues that require facial protection (17). The unprotected facial area has repeatedly been shown to be a high risk region for lacerations (10,12-15,18,22-25). In the present research, 74% of all lacerations were to the facial region. Players who did not wear any type of facial protection had a higher rate of facial injuries than players who wore either a full or half shield.

It was expected that the removal of the slapshot in the OTL would have resulted in a lower frequency of puck related injuries than in other adult leagues

that allow the slapshot. This was not the case as there was no significant difference in the distribution of injury mechanisms between the OTL and the AMRL. It is not clear why this is the case, however, it is possible that players in the OTL may tend to diminish the chances of receiving a puck related injury because of the slap-shot ban. This may cause players to participate in high risk activities such as shot-blocking that they may not have engaged in if they had considered the possibility of being hit by a slap-shot.

In recent injury research with elite male hockey players, the predominant injury mechanism was player contact through body checks or collisions (14,15,17,23). The percentage of injuries caused by player contact in these studies ranged from 58%(14) to 79%(18). Additionally Brust et al. (1) reported that 86% of the injuries suffered by a sample of 9-15 year old hockey players were caused by player contact. However, the aggregate percentage of injuries caused by player contact in the present research is substantially lower (40%). This indicates that the removal of body checking from the recreational game has partially modified one of the major mechanisms of injury in ice hockey. Regnier et al. (19) and Roy et al. (20) reported a similar reduction of body contact injuries in a comparison of 12-13 year olds playing in checking and non-checking leagues.

In terms of injury severity as a function of time lost from play, the results reported here are not dissimilar with the distribution of time lost reported in other studies (1,5,15). However, this comparison may be problematic as two of these studies were of minor hockey players (1,5), while the third was a study of elite hockey players that would have had access to coordinated rehabilitative treatment that would have accelerated their return to play (15). Six of the players injured in this study were hospitalized. Studies reporting hospitalization for hockey injuries are sparse, therefore it is difficult to compare the present results with prior work. However ,Voaklander et al. (25) reported only 14 hospitalizations for 4691 male hockey players for one year in Kingston, Ontario, with a solitary hospitalization for players over 17 years of age. The proportion of hospitalizations in the present research is higher than what would be expected based on these results. Unfortunately, the numbers of hospitalizations in both the Kingston study and the present research are much too small to be considered stable. More research needs to be conducted before conclusions can be reached concerning the severity of recreational ice hockey injuries as represented by the proportion of hospitalizations.

3.5 Conclusions

The information presented in this paper quantifies the incidence and nature of injuries suffered by samples of adult male recreational and old-timer ice hockey players.

The injury rates observed here were found to be lower than those reported for adult major/elite hockey. This was likely due to the removal of body checking and to a less intense level of play. Diagnostically and anatomically, the distribution of injuries in this study appears to be similar to other levels of hockey. However, the proportion of players injured through body contact was somewhat lower than that observed in adult major/elite hockey. This is also likely due, in part, to the removal of body checking as a legal tactic from the game.

Not knowing the extent of the puck injury problem in the OTL prior to the institution of the rule penalizing the slapshot, it is difficult to speculate on what effect on injury frequency this rule modification has had. However, the removal of the slapshot from the old-timers game does not appear to result in fewer puck related injuries in comparison to leagues where the slapshot is allowed.

Three recommendations can be made from the present research. It is recommended that Canadian Standards Association approved facial protection should be mandatory for all hockey, including adult recreational and old-timer leagues. Secondly, more research needs to conducted to examine the severity of recreational ice hockey injuries. This should include further quantification of the proportion of hospitalizations as well as long term follow-up of outcomes following serious injury. And finally, a detailed analysis should be conducted of puck related injuries in old-timers hockey to determine if any particular behavior is pre-disposing players for injury.

3.6 References

1 Brust JD, Leonard BJ, Pheley A, Roberts WO: Children's ice hockey injuries. *A J Dis Child* 1992;146:741-747.

2 Brison RJ: Risk of automobile accidents in cigarette smokers. *Can J Public Health* 1990;81:102-106.

3 Castaldi CR, Sparacio L, Wood AS, Bernard J. Injury rates in amateur, college, and professional hockey. In: Castaldi CR , Hoerner EF, eds. *Safety in Ice Hockey.* Philadelphia: ASTM, 1989:14-28.

4 Cohen J. *StatisticalPower for the Behavioral Sciences.* Hillsdale: Lawrence Erlbaum Associates, 1988.

5 Gerberich SG, Finke R, Madden M, Priest JD, Aamoth G, Murray K: An epidemiological study of high school ice hockey injuries. *Child's Nerv Syst* 1987;3:59-64.

6 Getz D: *Ice Use in Ontario Arenas.* Waterloo: University of Waterloo, 1988.

7 Grout P, Cliff KS, Harman ML, et al. Cigarette smoking, road traffic accidents, and seat belt usage. *Public Health* 1983;97:95-101.

8 Hastings DE, Cameron J, Parker SM, Evans J: A study of hockey injuries in Ontario. *Ontario Med Rev* 1974;Nov:686-698.

9 Hayes D: The nature, incidence, location and causes of injury in intercollegiate ice hockey. In: Taylor AW, ed. *Application of Science and Medicine to Sport.* Springfield: Thomas Publishing, 1975:292-300.

10 Hays D: An injury profile for hockey. *Can J App Sport Sci* 1978;3:61-64.

11 Hemenway D, Solnick SJ, Colditz GA. Smoking and suicide among nurses. *Am J Public Health* 1993;83:249-251.

12 Hornoff Z, Napravnik C: Analysis of various accident rate factors for ice hockey. *Med Sci Sports* 1973;5:283-286.

13 Jorgensen U, Schmidt-Olsen S: The epidemiology of ice hockey injuries. *Br J Sports Med* 1986;20:7-9.

14 Lorentzon R, Wendron H, Pietila T, Gustavsson B: Injuries in international ice hockey: A prospective, comparative study of injury incidence and injury types in international and Swedish elite ice hockey. *Am J Sports Med* 1988;16:389-391.

15 Lorentzon R, Wendron H, Pietila T: Incidence, nature, and causes of ice hockey injuries: A three-year prospective study of a Swedish elite ice hockey team. *Am J Sports Med* 1988;16:392-396.

16 Pashby TJ: Eye injuries in Canadian Amateur Hockey. *Can J Optham* 1985;20:2-4.

17 Pelletier RL, Montelpare WJ, Stark RM: Intercollegiate ice hockey injuries, a case for uniform definitions and reports. *Am J Sports Med* 1993;21:78-81.

18 Reeves JSH, Mendryk SW: A study of hockey injuries in the Greater Edmonton area. In: Taylor AW, ed. *Application of Science and Medicine to Sport*. Springfield: Thomas Publishing, 1975:301-308.

19 Regnier G, Boileau R, Marcotte G, et al. Effects of body-checking in the Pee-Wee (12 and 13 years old) Division in the province of Quebec. In: Castaldi CR , Hoerner EF, eds. *Safety in Ice Hockey*. Philadelphia: ASTM, 1989: 84-103.

20 Roy MA, Bernard D, Roy B, Marcotte G: Body checking in Pee Wee hockey. *Phys Sports Med* 1989;17:119-126.

21 Spss Inc: *Spss-x User's Guide*. Chicago: Spss Inc., 1988.

22 Sutherland GW: Fire on ice. *Am J Sports Med* 1976;4:264-269.

23 Tegner Y, Lorentzon R: Ice hockey injuries: incidence, nature and causes. *Br J Sports Med* 1991;25:87-89.

24 Toogood T, Love WG: Hockey injury survey. *J Can Assoc Health Phys Educ Recreat* 1966;32(2):20-23.

25 Voaklander DC, Brison RJ, Quinney HA, Macnab RB, Darko E: Ice hockey injuries treated in two emergency departments. *Clin J Sports Med* 1994;4:25-30.

CHAPTER 4

PERSONAL RISK FACTORS FOR INJURY IN RECREATIONAL ICE HOCKEY[1]

4.1 Introduction

There has been, lamentably, little research examining personal risk factors for injury in ice hockey. For the most part, ice hockey injury studies have confined themselves to reporting the frequency and nature of injuries with few commenting on or measuring factors that may predispose individual players to injury. Risk profiles that have been presented in the literature typically identify extrinsic factors that affect the frequency and severity of injury, however, intrinsic player characteristics have not been given similar attention (3,4,7,14).

The identification of a risk factor profile for recreational hockey has not been established. Existing risk profiles have derived their information from studies of minor, junior, intercollegiate, and professional hockey (3,4,7,14). Because the data for these publications were derived from substantially different populations, their generalizability to recreational athletes is problematic.

The data analyzed for this paper is from previous work that examined the incidence and nature of injury in adult male recreational leagues from Edmonton, Alberta (20). In this previous study, descriptive statistics were reported for both adult recreational (aged 18 years and older) and old-timer (aged 30 years and older) players. The old-timer players are not included in the present work, as their numbers were too small to provide sufficient statistical power for a risk factor analysis. Additionally, their age structure as well as differences in playing rules precluded their aggregation with the adult recreational players.

It was documented that the frequency of injury for adult recreational players was 12.3 injuries/1000 player-exposures. The predominant injury diagnosis was sprains/strains (35%), the anatomical site most often injured was the head/face/neck area (32%), and the most common injury mechanism was player contact through collisions or body checks (43%).

The current paper presents an analysis of personal risk factors for any injury as well as three specific types; facial injuries, body contact injuries (body checks and collisions), and sprain/strain injuries for adult male recreational players (aged 18 and over). The hypothesis is that due to the distinct nature of each of these injury types, unique personal risk factors can be identified.

4.2 Methods

Subjects for this research were recruited from recreational hockey leagues operating within the Greater Edmonton Area. Adult male recreational leagues include players age 18 years and older. The leagues are similar to traditional ice hockey with one major exception, intentional body contact is against the rules. Teams in this category were selected by proportional random sampling of the participating leagues with a minimum of 2 teams selected from each league until the desired sample size was reached.

---

[1]A version of this chapter has been submitted for publication by the American Journal of Sports Medicine.

Baseline risk factor data was collected via a questionnaire administered in the dressing room prior to the start of a team's first game of the 1992-93 hockey season. Information on playing position, facial protection, previous injury history was sought because of their documented relationship to injury frequency (7,10,11,16). Data were collected concerning age, height, weight, alcohol and tobacco use, occupation, fitness participation, skill level, and shooting side because of prior hypotheseses generated by the author that these variables may be related to injury in a recreational ice hockey population.

Injury and game/practice attendance data were collected at the end of each calendar month for the duration of the hockey season (including playoffs) by a telephone interview while diagnostic information for individuals who sought medical treatment was solicited from the attending health professional/institution. Informed consent was received from each study participant. For the purposes of this study an injury was defined as:

> *Any acute injury sustained while playing recreational hockey during any practice or game that results in an individual missing the remainder of a game/practice, a subsequent game/practice, and/or that requires an individual to consult a health professional.*

Initially, bivariate logistic regression was used to determine risk factors related to any injury. Data were then analyzed for 3 main injury types; facial injuries, body contact injuries (body checks and collisions), and sprain/strain injuries. Facial and eye injuries have been of particular importance to many researchers due to their high incidence and amenability to preventative reduction through the use of facial shields (10,11,13,17,19). Because body contact/collisions was the largest overall injury mechanism found in previous research concerning this data (20), an examination of player risk factors associated with these injuries was conducted . Risk factors for sprain/strain injuries are of interest due to the possible prevention of these injuries through a variety of conditioning techniques (1). Facial, body contact, and strain/sprain injuries were analyzed using bivariate logistic regression to delineate differences between injured and non-injured participants. The significance level for bivariate logistic regression was established as $p \leq .05$. Multiple logistic regression models were calculated for any injury as well as facial, body contact, and strain/sprain injuries adjusting for variables whose bivariate *p*-value was $\leq .10$. All data analyses were performed using SPSS statistical software (15).

4.3 Results

Three hundred and twenty-nine hockey players from 27 teams in 5 leagues were asked to participate in this project. Of these, 12 refused to fill out the demographic questionnaire. Another 20 filled out the questionnaire but did not consent to be subjects. A further 10 subjects were lost to follow-up before any injury or participation data could be collected from them. A comparison of subjects to those not consenting or that were lost to follow-up appears in Table 4-1. The final study sample consisted of 287 subjects or 87% of those initially asked to participate. As the hockey season progressed, 1 player moved out of Edmonton, 2 players quit hockey, and 7 players had phones disconnected for

which new numbers could not be found. Partial data for these players were included in these results.

Table 4-1
Subject demographics*

Variable	Subjects (n=287) mean±SD/%	Non-Responders (n=20) mean±SD/%	Lost to Follow-Up (n=10) mean±SD/%
Age (years)	28.9±5.5	31.4±6.0	28.0±5.4
Weight (kg)	81.0±9.6	79.6±10.5	80.5±10.7
Height (m)	1.79±0.06	1.78±0.05	1.79±0.09
BMI (kg/m^2)	25.4±2.7	25.1±2.9	25.1±1.8
Married	55.1%	70.0%	30.0%
Smoker†	11.5%	40.0%	10.0%
Alcohol Use			
< Once/Week	31.9%	20.0%	30.0%
1-3 Times/Week	59.4%	55.0%	60.0%
>3 Times/Week	8.7%	25.0%	10.0%
Occupation			
Unskilled	10.2%	15.0%	33.3%
Trades	15.3%	25.0%	22.2%
Manager	11.5%	15.0%	
Student	8.5%	10.0%	
Professional	54.6%	35.0%	44.4%
Injured in Past Year	39.9%	32.4%	40.1%
Participates in Other Fitness Activities	76.6%	35.0%	44.4%

*Non-responders were grouped with those lost to follow-up for statistical comparison with study subjects.
†(p=.003;Chi-square=8.9)

There were a total of 100 injuries reported by 87 players in the 92/93 hockey season. Table 4-2 outlines personal risk factors for any injury. Bivariately, skilled trade occupational status, participation in strength training, and shooting left were significantly associated with injury status. For any injury occupation, previous injury, participation in strength training, and shooting left were significantly associated with injury status in the multiple logistic regression model (Table 4-3).

Table 4-2
Risk factors for any injury - bivariate logistic regression

Factor	Odds Ratio	95% Confidence Interval	*p*
Age (year)	1.03	0.98,1.07	.21
Weight (kg)	0.99	0.97,1.02	.61
Height (m)	0.48	0.01,25.5	.72
BMI (kg/m^2)	0.98	0.89,1.07	.65
Alcohol Use			
>3 Times/Week	1.09	0.81,4.48	.14
1-3 Times/Week	0.83	0.49,3.24	.49
< Once/Week	1.00		
Smoker	0.61	0.26,1.40	.24
Occupation			
Unskilled	0.35	0.12,1.06	.06
Trades	2.00	1.02,3.93	.04
Manager	1.09	0.49,1.09	.83
Student	1.11	0.98,4.95	.08
Professional	1.00		
Injured in Past Year	1.56	0.96,2.53	.07
Participates in an Aerobic Activity	1.57	0.95,2.59	.08
Participates in Another Team Sport	1.22	0.73,2.03	.45
Participates in a Racquet Sport	0.99	0.51,1.95	.99
Participates in Strength Training	1.78	1.01,3.06	.05
Facial Protection			
Full	0.69	0.38,1.26	.23
Half	0.84	0.42,1.67	.62
None	1.00		
Typical Pre-game Warm-up			
Stretching	0.70	0.31,1.59	.40
Stretching and Skating	1.12	0.49,2.60	.79
None	1.00		
Position			
Forward	1.24	0.49,3.14	.65
Defense	2.05	0.78,5.46	.15
Goal	1.00		
Self-appraised Skill Level			
Above Average	0.66	0.26,1.64	.37
Average	0.77	0.33,1.81	.55
Below Average	1.00		
Shoots Left	1.67	1.00,2.79	.05

Table 4-3
Risk factors for any injury - multiple logistic regression

Factor	Adjusted Odds Ratio	95% Confidence Interval	*p*
Occupation			
Unskilled	0.49	0.16,1.52	.21
Trades	2.71	1.33,5.55	.006
Manager	1.28	0.57,2.92	.54
Student	2.50	1.03,6.05	.04
Professional	1.00		
Previous Injury	1.76	1.04,2.98	.03
Participates in an Aerobic Activity	1.18	0.68,2.04	.56
Participates in Strength Training	1.81	0.99,3.32	.053
Shoots Left	1.78	1.03,3.08	.04

Twenty-five facial injuries were suffered during the 92/93 hockey season, while 43 injuries were the result of body contact, and 34 injuries were diagnosed as sprain/strains. Bivariately, shooting left was the only statistically significant risk factor for facial injuries (Table 4-4). Shooting left was found to be significant when occupation and facial protection were controlled for in a multiple logistic regression model of facial injury factors (Table 4-5).

Table 4-4
Risk factors for facial injuries - bivariate logistic regression

Factor	Odds Ratio	95% Confidence Interval	*p*
Age (year)	0.99	0.91,1.06	.69
Weight (kg)	1.00	0.96,1.05	.84
Height (m)	13.27	0.01,>100.00	.47
BMI (kg/m^2)	0.98	0.84,1.15	.80
Alcohol Use			
>3 Times/Week	1.61	0.46,5.69	.46
1-3 Times/Week	0.71	0.29,1.76	.46
< Once/Week	1.00		
Smoker	0.68	0.15,3.04	.62
Occupation			
Unskilled	0.39	0.05,3.12	.38
Trades	1.11	0.34,3.59	.86
Manager	0.71	0.15,3.31	.66
Student	2.85	0.92,8.83	.07
Professional	1.00		
Injured in Past Year	1.57	0.69,3.56	.28
Participates in an Aerobic Activity	0.73	0.30,1.82	.50
Participates in Another Team Sport	0.99	0.41,2.39	.99
Participates in a Racquet Sport	1.46	0.52,4.12	.47
Participates in Strength Training	1.64	0.68,3.99	.27
Facial Protection			
Full	0.24	0.05,1.06	.06
Half	0.78	0.25,2.42	.67
None	1.00		
Typical Pre-game Warm-up			
Stretching	>100.00	< .01,>100.00	.70
Stretching and Skating	>100.00	< .01,>100.00	.70
Neither	1.00		
Position			
Forward	1.61	0.20,13.03	.66
Defense	4.59	0.60,36.97	.15
Goal	1.00		
Self-appraised Skill Level			
Above Average	0.43	0.12,1.62	.21
Average	0.44	0.13,1.44	.17
Below Average	1.00		
Shoots Left	4.92	1.43,16.83	.01

Table 4-5
Risk factors for facial injuries - multiple logistic regression

Factor	Adjusted Odds Ratio	95% Confidence Interval	*p*
Occupation			
Unskilled	0.48	0.06,3.89	.48
Trades	1.28	0.38,4.26	.69
Manager	0.87	0.18,4.18	.86
Student	3.09	0.93,10.28	.07
Professional	1.00		
Facial Protection			
Full	0.31	0.07,1.44	.14
Half	1.01	0.31,3.34	.98
None	1.00		
Shoots Left	5.25	1.46,18.82	.01

For players suffering injury due to body contact, bivariate logistic regression analysis determined that body mass index (BMI), student occupational status, alcohol use, and weight were all significantly related to injury outcome (Table 4-6). Occupation and weight were found to be significant when controlling for alcohol use, playing position, and team sport participation in a multiple logistic regression model of body contact injuries (Table 4-7).

Table 4-6
Risk factors for body contact injuries - bivariate logistic regression

Factor	Odds Ratio	95% Confidence Interval	*p*
Age (year)	1.04	0.99,1.121	.15
Weight (kg)	0.94	0.83,0.98	.003
Height (m)	0.82	<0.01,23.41	.43
BMI (kg/m^2)	0.80	0.72,0.94	.005
Alcohol Use			
>3 Times/Week	0.63	0.20,2.04	.44
1-3 Times/Week	0.46	0.23,0.92	.03
< Once/Week	1.00		
Smoker	1.08	0.39,2.96	.89
Occupation			
Unskilled	<0.01	<0.01,>100.00	.69
Trades	1.38	0.54,3.51	.50
Manager	1.94	0.74,5.06	.18
Student	3.52	1.34,9.25	.01
Professional	1.00		
Injured in Past Year	1.56	0.81,2.97	.18
Participates in an Aerobic Activity	1.32	0.68,2.56	.42
Participates in Another Team Sport	1.84	0.95,3.56	.07
Participates in a Racquet Sport	1.35	0.58,3.14	.48
Participates in Strength Training	1.55	0.76,3.16	.23
Facial Protection			
Full	1.18	0.56,2.48	.67
Half	0.70	0.25,1.94	.49
None	1.00		
Typical Pre-game Warm-up			
Stretching	0.49	0.18,1.35	.17
Stretching and Skating	0.89	0.32,2.49	.83
Neither	1.00		
Position			
Forward	4.17	0.54,32.03	.17
Defense	5.88	0.74,46.59	.09
Goal	1.00		
Self-appraised Skill Level			
Above Average	1.72	0.36,8.27	.50
Average	2.17	0.48,9.69	.31
Below Average	1.00		
Shoots Left	1.48	0.74,2.97	.27

Table 4-7
Risk factors for body contact injuries - multiple logistic regression

Factor	Odds Ratio	95% Confidence Interval	*p*
Weight (kg)	0.95	0.91,0.99	.01
Alcohol Use			
>3 Times/Week	0.81	0.22,3.02	.76
1-3 Times/Week	0.52	0.24,1.15	.12
< Once/Week	1.00		
Occupation			
Unskilled	<0.01	<0.01,>100.00	.70
Trades	0.98	0.36,2.69	.97
Manager	2.03	0.74,5.54	.17
Student	2.96	1.07,8.18	.04
Professional	1.00		
Participates in Another Team Sport	1.38	0.66,2.89	.39
Position			
Forward	3.19	0.39,25.83	.28
Defense	5.78	0.69,48.23	.11
Goal	1.00		

The occurrence of strains/sprains was significantly related to age and skilled trade occupational status (Table 4-8). No factors were found to be significantly related to strain/sprain injuries when both age and occupational status were controlled for in a multiple logistic regression model (Table 4-9).

Table 4-8
Risk factors for strain/sprain injuries - bivariate logistic regression

Factor	Odds Ratio	95% Confidence Interval	*p*
Age (year)	1.07	1.01,1.13	.02
Weight (kg)	1.00	0.96,1.04	.99
Height (m)	0.35	<0.01,123.37	.73
BMI (kg/m^2)	1.00	0.88,1.15	.95
Alcohol Use			
>3 Times/Week	0.93	0.24,3.58	.91
1-3 Times/Week	1.00	0.46,2.18	.99
< Once/Week	1.00		
Smoker	0.76	0.22,2.64	.67
Occupation			
Unskilled	0.36	0.05,2.86	.34
Trades	2.63	1.05,6.54	.04
Manager	1.81	0.60,5.42	.29
Student	1.43	0.38,5.39	.60
Professional	1.00		
Injured in Past Year	1.11	0.54,2.28	.77
Participates in an Aerobic Activity	1.22	0.59,2.56	.59
Participates in Another Team Sport	1.56	0.75,3.24	.23
Participates in a Racquet Sport	0.73	0.24,2.18	.57
Participates in Strength Training	1.03	0.44,2.39	.95
Facial Protection			
Full	1.36	0.60,3.08	.46
Half	0.78	0.25,2.42	.67
None	1.00		
Typical Pre-game Warm-up			
Stretching	0.57	0.19,1.69	.31
Stretching and Skating	0.65	0.21,2.03	.46
Neither	1.00		
Position			
Forward	0.95	0.26,6.21	.90
Defense	1.15	0.29,4.51	.72
Goal	1.00		
Self-appraised Skill Level			
Above Average	0.60	0.19,1.90	.39
Average	0.41	0.14,1.23	.11
Below Average			
Shoots Left	0.98	0.47,2.04	.95

Table 4-8
Risk factors for sprain/strain injuries - multiple logistic regression

Factor	Adjusted Odds Ratio	95% Confidence Interval	*p*
Occupation			
Unskilled	0.39	0.05,3.13	.38
Trades	2.41	0.96,6.09	.06
Manager	1.65	0.54,5.01	.38
Student	2.06	0.49,8.55	.32
Professional	1.00		
Age (years)	1.05	0.98,1.12	.14

4.4 Discussion

It is interesting to note that the only significant difference between the study subjects and those not participating or lost to follow-up was in the proportion of smokers. It is not clear from the information available why smokers would decline to be participants, however, it may relate to further non-conformist behavior as smokers were the clear minority in this population. Other research has found smoking to be a risk factor related to traumatic events such as suicide (11) and motor vehicle accidents (2). Additionally, smokers tend to exhibit high risk behaviors such as reduced seat belt usage (7). The smokers remaining in this study did not appear to be at an increased risk for any of the injuries examined. However, there remains the possibility that some selection bias exists as the smokers in the sample may not be representative of all smokers playing ice hockey.

Few researchers have presented examinations of individual risk factors for injury in ice hockey. This is most likely because the homogeneous nature of the populations studied precluded the identification of any salient injury related factors that differed between players. The initial endeavor in the present study was to look at risk factors for all injuries combined in an effort to come up with an individual risk profile. While this was possible (Tables 4-2 and 4-3), the factors, for the most part, defied concise rationalization given the diverse nature of injuries in ice hockey. Examining the injuries as a group may mask important risk factors for specific injury types. Therefore to make the examination of risk factors more meaningful, injuries were broken down into 3 types; facial injuries, body contact injuries, and sprains/strain injuries. These 3 specific injury types will be discussed first.

There were 25 facial injuries reported during the 92/93 hockey season by the study participants. It was expected that facial protection would be the major factor related to facial injuries in this population as this type of protection is not mandatory in these leagues. While this was not shown in the present analysis, it is likely due to a lack of statistical power, rather than a lack of clinically significant effect. In fact, in our previous work with this data, a significant protective relationship of facial protection was found when the entire sample of old-timer and adult male recreational players were analyzed as a single group (20). This being said, shooting on the left side of the body appeared in this research, to be the predominant factor related to facial injury with players shooting left having an almost 5 fold increase in risk. This does not appear to be related to playing

position, as the interaction of these variables was measured and found to be non-significant. Further examination of the injury pattern determined that 46% of facial injuries were caused by puck contact and another 46% was caused by stick contact. Eighty-five percent of these puck and stick injuries were to players that shot left. While only 5 to 10 percent of the population is left handed (18), 58% of all players in this sample shot left. It would seem from these results that left shooting players may have increased difficulty avoiding objects directed towards their face. While this relationship defies a definitive explanation given the nature of this research, at least two possibilities may exist. The first is that position on the ice surface at the time of injury may be a factor that interacts with both shooting style and playing position to increase the risk of injury for those shooting left. For the most part injuries have been found to occur between the end boards and the blue line (7) with the end boards and corners having a particularly high incidence (9). Unfortunately, information on ice position at the time of injury was not collected in the present research. A second possibility is that facial injuries suffered by left shooting players may be related to some type of reaction time deficit. Right handers, manipulating objects (hockey stick and/or puck) on the left side of their bodies may not be able to avoid objects directed at their faces as quickly as players using their sticks on their dominant side. Hand/hemisphere asymmetrical organization has been postulated as a basic control process that affects the coordination of inter-limb movements (12). Additionally, slow reaction time to a visual stimulus has been related to soccer injuries (16). Further research needs to be conducted before any definite conclusions can be reached concerning facial injuries and the laterality of stick usage.

Although body checking has been deemed a penalizable behavior in the leagues studied, as an injury mechanism, it still accounted for 22% (n=22) of the injuries observed. There were also 21 injuries (21% of all injuries) as a result of collisions with other players. Student occupational status appears to be a risk factor for injury via body contact. This is conceivably due to a propensity for aggressive and high risk play likely at a greater velocity than members of other occupational categories engage in. Given that students in this sample were the youngest occupational category, it is surprising that a younger age is not also related to an increased injury frequency. However, it is possible that high risk behavior may have a greater association with a less structured occupational requirement than simply age. In the present case, students may have less occupational responsibility (or financial obligation), thus the consequences of injury may be perceived as less of a disruption to their lives. Body mass index (BMI) and weight were also significantly related to body contact injuries. With less mass to absorb impact, the consequences of body contact are likely to be negative for the lighter player. Bivariately, the moderate use of alcohol (1-3 times per week) appeared to provide a protective effect. This relationship did not remain robust when other variables were controlled for multivariately. This is likely due to the relationship of alcohol use to weight. Moderate drinkers reported a significantly greater weight than other players in the sample ($p=.05$; t-test).

Bivariately advancing age was a factor related to sprain/strain injuries. This is to be expected as recreational players become deconditioned with age. While the will to perform at a certain level may not have waned over time, physical capabilities have, for many recreational participants, diminished through decreased overall activity. Skilled trades occupational status was also a bivariate

risk factor for sprain/strain injuries. Trades people may be predisposed to athletic injuries due to nature of their occupations. Trades people suffered 60% of all knee sprains while accounting for only 15% of the total subjects. The lower extremity, in particular the knee, has been found to be an area that is commonly injured by skilled trades persons (21). Neither age or trades occupational status remained statistically robust when the other was controlled for in the multiple logistic regression model. This indicates that they must share a substantial proportion of the variation in sprain/strain injury status with neither one of them providing a significantly better fit than the other. Trades persons were significantly older than students and unskilled persons ($p<.001$; one-way ANOVA).

The preceding discussion has covered all of the variables that appear as significant risk factors for all injuries with the exception of an activity limiting injury in the previous year. Results from the multiple logistic regression model indicate that players reporting an activity limiting injury in the year prior to the 92/93 season had a 76% greater chance of receiving a subsequent injury (Table 4-3). This is not surprising, as most individuals at the recreational level would not have access to a coordinated rehabilitation program for their injuries. Neglect and premature return to play are significant factors in the re-injury of athletes (1,5). It has also been hypothesized that impaired timing and neuromuscular coordination are related to sequential injuries occurring in different anatomical locations (5). In addition, equipment usage could also be a factor. For example, players not using facial protection could possibly be repeat recipients of facial trauma.

A limitation of the present research is that the sample size may not have been adequate to statistically corroborate some clinically significant risk factors. Both facial protection and playing position failed to achieve statistical significance in any of the models presented. Playing position has been found in previous research to be related to injury with forwards having the highest frequency (7). In the multivariate model for body contact injuries presented in Table 4-7, both defencemen and forwards exhibit large odds ratios for injury when compared to goaltenders. A larger sample size may have statistically verified these results.

4.5 Conclusions

The information presented in this paper quantifies risk factors for all injuries as well as three major ice hockey injury categories; facial injuries, body contact injuries, and strain/sprain injuries. The utility of dividing injuries into major categories for risk factor identification was shown, as specific risk factors were identified for each of the three injury categories.

Recommendations arising from this paper address three areas. The first is that players should be encouraged, if injured, to seek proper rehabilitation advice and services. A comprehensive rehabilitation plan may reduce the chance of re-injury.

Secondly, more research focusing on individual risk factors should be conducted with ice hockey players at all skill and age levels. Shooting left as a risk factor for facial injury could be a subject of further inquiry for motor control researchers as no definitive explanation of this phenomenon is presently available. As it is a non-modifiable risk factor, it would be of limited utility to invest further injury control resources determining its relationship to facial injury.

In any case, regardless of shooting side, all players should be encouraged to use Canadian Standards Association approved facial protection to reduce the chances of a blinding eye injury or facial/dental disfigurement.

And finally, the methods used in this study to examine risk factors for specific injury types should be attempted with other sports populations. Investigators should, however, pay close attention to sample size considerations to make sure there is sufficient statistical power to not falsely reject significant risk factors. In the present study, both facial protection and playing position failed to reach statistical significance, while both are likely clinically significant contributors to the injury experience of recreational ice hockey players.

4.6 References

1 Arnheim DD: *Modern Principles of Athletic Training.* St. Louis: CV Mosby Company, 1985.

2 Brison RJ: Risk of automobile accidents in cigarette smokers. *Can J Public Health* 1990;81:102-106.

3 Castaldi CR, Sparacio L, Wood AS, Bernard J. Injury rates in amateur, college, and professional hockey. In: Castaldi CR , Hoerner EF, eds. *Safety in Ice Hockey.* Philadelphia: ASTM, 1989:14-28.

4 Daly PJ, Sim FH, Simonet WT: Ice hockey injuries a review. *Sports Med* 1990;10:122-131.

5 Ekstrand J and Gillquist J: Soccer injuries and their mechanisms: a prospective study. *Med Sci Sports Exerc* 1983;15:267-270.

6 Grout P, Cliff KS, Harman ML, et al. Cigarette smoking, road traffic accidents, and seat belt usage. *Public Health* 1983;97:95-101.

7 Hayes D: An injury profile for hockey. *Can J App Sport Sci* 1978;3:61-64.

8 Hemenway D, Solnick SJ, Colditz GA. Smoking and suicide among nurses. *Am J Public Health* 1993;83:249-251.

9 Keating M, Norris R. Design of hockey rinks and the development of standards. In: Castaldi CR , Hoerner EF, eds. *Safety in Ice Hockey.* Philadelphia: ASTM, 1989: 187-201.

10 Lorentzon R, Wendron H, Pietila T, Gustavsson B: Injuries in international ice hockey: A prospective, comparative study of injury incidence and injury types in international and Swedish elite ice hockey. *Am J Sports Med* 1988;16:389-391.

11 Lorentzon R, Wendron H, Pietila T: Incidence, nature, and causes of ice hockey injuries: A three-year prospective study of a Swedish elite ice hockey team. *Am J Sports Med* 1988;16:392-396.

12 Marteniuk RG and MacKenzie CL. A preliminary theory of two hand coordinated control. In: Stelmach GE and Requin J, eds. *Tutorials in Motor Behavior*. Amsterdam: North Holland, 1980: 185-197.

13 Pelletier RL, Montelpare WJ, Stark RM: Intercollegiate ice hockey injuries, a case for uniform definitions and reports. *Am J Sports Med* 1993;21:78-81.

14 Sim FH, Simonet WT, Melton LJ, Lehn TA: Ice hockey injuries. *Am J Sports Med* 1987;15:30-40.

15 Spss Inc. Spss-x User's Guide. Chicago: Spss Inc., 1988.

16 Taimela S, Kujala UM, Osterman K: Intrinsic risk factors and athletic injuries. *Sports Med* 1990;9:205-215.

17 Tegner Y, Lorentzon R: Ice hockey injuries: incidence, nature and causes. *Br J Sports Med* 1991;25:87-89.

18 Vander Zanden JW. *Human Development*. New York: Alfred A. Knopf, 1981.

19 Voaklander DC, Brison RJ, Quinney HA, Macnab RB, Darko E: Ice hockey injuries treated in two emergency departments. *Clin J Sports Med* 1994;4:25-30.

20 Voaklander DC: *Recreational Ice Hockey Injuries*. Edmonton: University of Alberta, 1994.

21 Voaklander DC: Unpublished data. *Workers' Compensaton Board of Alberta*. Edmonton, 1994.

CHAPTER 5

OVERVIEW AND FUTURE DIRECTIONS

5.1 Overview

The preceding chapters have examined the nature and incidence of recreational ice hockey injuries. Chapter 1 provided a review of previous research that has spanned over 25 years and has examined ice hockey injuries at a variety of playing levels using an assortment of data sources. Chapter 2 presented an analysis of ice hockey injury data for an entire community-year derived from two emergency departments. Chapter 3 provided prospective information on the incidence and nature of injuries from adult recreational and old-timers hockey, while Chapter 4 examined personal risk factors for adult recreational ice hockey injuries.

At the conclusion of Chapter 1, several research questions were posed given the logic that recreational ice hockey is a unique hockey strata that mandates specific research concerning its injury incidence and nature. The results presented in Chapters 2 through 4 provide support for this hypothesis.

Chapter 2 concluded that recreational players may be at a higher risk of facial injury because the leagues they play in do not require the use of facial protection. Chapter 2, however, was essentially an ecological study that provided no information on individual exposure to types of facial protection.

Chapter 3 supplied information from a more powerful prospective design that followed individual hockey players through an entire season quantifying their injury experience. Again in Chapter 3, mandatory facial protection for recreational ice hockey was recommended as the risk of facial injury was noted to be greater in comparison to research that had examined populations in which facial protection was requisite. It was also concluded that the injury rate was lower for recreational ice hockey both at the general recreational and old timers levels than major/elite populations. This was likely due to the penalization of body checking and a lower intensity of play at the recreational and old-timers levels. Anatomically and diagnostically, the distribution of injuries in this chapter was found to be similar to previously reported work.

Chapter 4 presented an investigation of personal risk factors for ice hockey injuries in a recreational population. Whether or not the injury risk models derived from this work are applicable to other hockey populations is unknown as no similar analysis has been presented. Certainly, some of the factors identified, such as previous injury history have been presented by others as risk factors for injury, however, several new factors such as weight and shooting side were presented. Other factors such as occupational category and age may not be applicable to other hockey populations as they would be relatively homogenous on these variables (eg. all minor hockey players would be students). More risk factor investigation needs to be conducted to determine if the risk factors presented here are robust across different hockey playing levels and ages.

The contribution of the present research to the body of knowledge regarding ice hockey injuries, for the most part, lies in its examination of a population of players that have not been seriously investigated by others. While Hornoff and Napravnik (2) presented an audit of insurance claim records for ice

hockey which included adult recreational players, their analysis did not stratify by age or level of play, making it impossible to come to any specific conclusions regarding adult recreational populations. Others have made recommendations concerning facial protection requirements for recreational ice hockey, but these have arisen from ecological inference rather than an analytical epidemiological examination of recreational ice hockey (1,3).

5.2 Future Directions

The use of emergency department data for the examination of sports injuries has not been widely used in Canada. The detail of information that was available for the analysis presented in Chapter 2 indicates that a wealth of relatively untapped data is available. At the present time, the largest standardized injury information gathering system in Canada is the Children's Hospital Injury Research and Prevention Program (CHIRPP) that is federally administered by the Laboratory Centre for Disease Control in Ottawa (5). This program, however, is specific to children and with few hospitals extending the data collection to adult injuries. Additionally, the Product Safety Branch of Consumer and Corporate Affairs Canada collects data from a small number of hospitals regarding product safety via the Canadian Accident Injury Reporting and Evaluation Project (CAIRE). The major limitation with both of these data sources is that they are hospital rather than population based (5). The organization of provincial and/or federal population based hospital data collection systems would add greatly to the ability of injury reduction strategists to identify recreational injury trends. Additionally, the use of emergency department data for smaller more specific studies as presented in Chapter 2 could provide useful information on sport and recreation injuries for discrete activities or for a defined population.

The methods used to gather data for Chapters 3 and 4 of this research worked very well with a relatively non-structured recreational ice hockey population. The methods proved to be efficient, accurate, and acceptable to subjects as well as the medical community. These methods could be used to examine the injury pattern in a wide variety of both team and individual sports at the recreational level. Researchers should, however, plan to offer a monetary incentive for data collection from the medical community, as many of them charge a fee for any forms they fill out, regardless of whether they are for research or for other purposes such as insurance claims or medical clearance examinations.

Risk factor analysis is in its relatively infancy with regard to sports injuries (6). The risk factor analysis presented in Chapter 4 indicates that specific athlete attributes related to increased or decreased injury status can be identified for recreational ice hockey. These methods, therefore, should be applied to other studies of sport and recreation injuries to determine as accurately as possible, factors related to injury status. Walter et al. (7) has identified the lack of analytical risk factor analysis as a major limiting factor in the study of sports injuries.

Two aspects of risk factor analysis should be considered carefully by those planning this type of study. The first is that the sample size should be adequate enough to assure that true causal connections are not falsely rejected. Often

sport injury studies present the results of the injury experience of a single team or a small league, typically during a season of play. Samples of this size are likely not large enough for a meaningful risk factor analysis to be conducted. Secondly, a variety of information including demographics, previous injury history, physiological data, and any hypothesized risk factors should be collected as completely as possible for all subjects. Often, a major criticism of risk factor studies is the lack of control for variables that are related to both the outcome and the resulting risk factors (4).

Future direction for ice hockey injury research should include further exploration of the relationship of shooting side to facial injuries. Studies investigating this relationship should control for handedness and reaction time to visual stimuli. Additionally, a detailed analysis of the interaction between playing position and ice surface position at the time of injury should also be undertaken to identify any patterns that may exist with regard to facial injuries and shooting side. Further research should also be conducted to find out why so many adult recreational players do not wear facial protection.

5.3 References

1 Castaldi CR, Sparacio L, Wood AS, Bernard J. Injury rates in amateur, college, and professional hockey. In: Castaldi CR , Hoerner EF, ed. *Safety in Ice Hockey.* Philadelphia: ASTM, 1989:14-28.

2 Hornoff Z, Napravnik C: Analysis of various accident rate factors for ice hockey. *Med Sci Sports* 1973;5:283-286.

3 Pashby TJ: Eye injuries in Canadian amateur hockey. *Can J Optham* 1985;20:2-4.

4 Robertson LS: *Injury Epidemiology*. New York: Oxford University Press, 1992.

5 Saunders LD, Stewart LM, eds: *A Safer Canada - Year 2000 Injury Control Objectives for Canada*. Edmonton: Injury Awareness and Prevention Centre, University of Alberta Hosptitals, 1991.

6 Taimela S, Kujala UM, Osterman K: Intrinsic risk factors and athletic injuries. *Sports Med* 1990;9:205-215.

7 Walter SD, Sutton JR, McIntosh JM, Connolly C: The aetiology of sport of sport injuries: a review of the methodologies. *Sports Med* 1985;2:47-58.

APPENDIX A

TITLE OF RESEARCH PROJECT: **The Epidemiology of Recreational Ice Hockey Injuries**

INVESTIGATORS:
L. Duncan Saunders, Department of Health Services Administration and Community Medicine, University of Alberta
D.C. Voaklander, Department of Physical Education, University of Alberta
H.A. Quinney, Department of Physical Education, University of Alberta
R.B.J. Macnab,, Department of Physical Education, University of Alberta

INFORMATION SHEET:

As researchers at the University of Alberta, we are conducting a project examining the frequency and nature of injuries suffered by recreational hockey players. The results of this project will be used to help make recreational hockey a safer and more enjoyable experience for participants.

Participation in this project will require about 15 minutes of your time as you fill out a short questionnaire.

In addition, you will be contacted at the end of each calendar month by telephone and asked a brief series of questions about any injuries you may have suffered in the previous month playing hockey. If you have suffered an injury that required medical treatment, we will ask at that time that you allow the attending health professional to fill in a form detailing the diagnosis of the injury you have suffered and how it was managed.

There will be no personal evaluations made and all information given by you will be dealt with confidentially. No individual will be identified in any reports resulting from this project.

On the last page of this questionnaire there are spaces for you to give your name and phone number. Your signature is also required, as a sign of your willingness to participate in this important project . Your participation is voluntary and you may withdraw your consent at any time during the course of the project.

APPENDIX A

1. What is your age?

   _____ Years

2. What is your height?

   _____ Feet _____ Inches or _____ Meters

3. What is your weight?

   _____ Pounds or _____ Kilograms

4. What is your marital status?

   - ☐ Not married
   - ☐ Married/Common Law
   - ☐ Divorced
   - ☐ Widowed

5. What is your smoking status?

   - ☐ Cigarette smoker; 1 or more packs a day
   - ☐ Cigarette smoker; less than 1 pack a day
   - ☐ Cigars/Pipe
   - ☐ Non-smoker

6. How often, on average, do you drink alcoholic beverages?

   - ☐ Every day
   - ☐ 4-6 times a week
   - ☐ 2-3 times a week
   - ☐ Once a week
   - ☐ Once or twice a month
   - ☐ Less often than once a month
   - ☐ Non-drinker

7. What is your present occupation? (eg. lawyer, carpenter, homemaker)

   _____

8. How skilled are you at hockey compared to the players you compete against? (Be honest)

   - ☐ Excellent skill
   - ☐ Above average skill
   - ☐ Average skill
   - ☐ Below average skill
   - ☐ Poor skill

APPENDIX A

9. When was the last season that you played hockey?

- ☐ Last winter season
- ☐ 2 to 5 years ago
- ☐ Last summer season
- ☐ Longer than 5 years ago

10. In the past 12 months, have you suffered an injury as a result of doing sports or exercise that limited your ability to participate in sports or exercise?

- ☐ Yes
- ☐ No

11. If you anwered yes to Question #10, please list the activity(s) that resulted in an injury in the past 12 months and the nature of the injury.

Activity_____ Type of injury _____

Activity_____ Type of injury _____

Activity_____ Type of injury _____

12. Other than hockey, do your currently participate in any physical activity, program (either on your own or in a formal class) or sport designed to improve or maintain your physical fitness?

- ☐ Yes
- ☐ No

13. If you answered yes to Question #12, please list the activity(s) than you participate in.

_____

14. What position do you most often play?

- ☐ Right Wing
- ☐ Left Wing
- ☐ Center
- ☐ Left Defence
- ☐ Right Defence
- ☐ Goaltender

15. Do you shoot with a left or right hockey stick?

- ☐ Left
- ☐ Right

16. What type of face/mouth protection do you use?

- ☐ None
- ☐ Full Plastic
- ☐ Mouth Piece
- ☐ Full Grill
- ☐ Partial Plastic

APPENDIX A

17. Do you wear a knee brace?

- [ ] No
- [ ] Yes and it is custom made.
- [ ] Yes and it is off the store shelf.

18. Do you normally wear glasses or contact lenses?

- [ ] No
- [ ] Yes

19. If you answered yes to question #18, do you wear your glasses or contacts while playing hockey?

- [ ] Does not apply
- [ ] Yes
- [ ] No

20.Just before this hockey season started, how many times did you practice, play in exhibition games or simply go skating?

- [ ] None
- [ ] 1 to 2 times
- [ ] 3 to 4 times
- [ ] 5 to 6 times
- [ ] More than 6 times

21. Other than shooting and passing the puck around does your pre-game warm-up include:

- [ ] Vigorous skating
- [ ] Stretching
- [ ] Vigorous skating and stretching.
- [ ] Neither vigorous skating or stretching.

22. What brand of helmet do you wear?

_____

23. How old is the helmet that you wear?

_____ Seasons

24. What is the **main** reason you play hockey?

- [ ] Friendship with teammates.
- [ ] Personal fitness.
- [ ] Team achievement. (winning)
- [ ] Excitement.
- [ ] Personal achievement. (skill development)

APPENDIX A

The Epidemiology of Recreational Ice Hockey Injuries

CONSENT

I have read the information included with this questionnaire and agree to participate in this research project. I understand that all of the answers I have given and future information that I may provide will be confidential and will be used only as group data in research. I also give the research team permission to contact my physician regarding any injuries I receive playing hockey during the 1992-93 season. I have received a copy of the information sheet and this consent form for my own records and I understand that I may withdraw my participation in this research project at any time I choose.

Persons who may be contacted about this research are:

NAME:	PHONE:
Don Voaklander	438-0653
Duncan Saunders	492-6814
Art Quinney	492-3364
Ross Macnab	492-5601

TEAM_____

NAME (please print)_____

PHONE NUMBER_____

SIGNATURE_____DATE_____

WITNESS_____

PRINCIPAL INVESTIGATOR_____

Thank you for your participation.

APPENDIX B

TELEPHONE DATA CONTACT SHEET

SUBJECT NAME:_____

TELEPHONE NUMBER:_____

NOTES:

Hello, is Mr._____ at home?

Hello, Mr._____, this is _____ calling from the University of Alberta. I am calling you because you have voluteered as a participant in a project examining hockey injuries. Do you have a few minutes to answer some questions concerning any injuries you may have suffered in the month of_____. The interview will only take about 5 minutes and your answers will be confidential. Feel free to ask any questions at any time. OK?

1. How many league games have you missed in the month of_____ ?

_____

2. How many tournament games have you played in the month of_____ ?

_____

3. How many practices have you had in the month_____?

_____

4. Have you had an injury from hockey that has prevented you from completing a game, caused you to miss a game, or that has required you to seek medical treatment in the month of_____?

☐ No
☐ Yes

If yes to question #3 go to next page. If no, thank Mr._____ for his cooperation.

APPENDIX B

5. Did you have to see a doctor any or other health care professional concerning your injury?

- ☐ Yes
- ☐ No

6. If yes to Question #1; Where did you go to seek treatment and who did you see?

Name of Institution _____ Date _____

Name of Health Professional _____

7. What typeof injury did you receive? (Circle appropriate items on list below)

BODY PART			CONDITION
Head	Forearm	Groin	Abrasion
Face	Wrist	Thigh	Contusion
Eye	Hand	Knee	Laceration
Jaw/Chin	Thumb	Shin	Strain
Teeth/Mouth	Finger	Calf	Sprain
Nose	Chest	Ankle	Dislocation
Throat	Upper Back	Foot	Fracture
Neck	Lower Back	Heel	Nerve damage
Shoulder	Abdomen	Toes	Concussion
Upper Arm	Genitalia		
Elbow	Hip		
Spinal Cord			

8. During which of the following did the injury occur?

- ☐ League game
- ☐ Tournament game
- ☐ Play-off game
- ☐ Practice

9. During which period of play did the injury occur?

- ☐ 1st period
- ☐ 2nd period
- ☐ 3rd period
- ☐ Overtime
- ☐ Pre-game warm-up

APPENDIX B

10. What position were you playing when you were injured?

- ☐ Right Wing
- ☐ Left Wing
- ☐ Center
- ☐ Left Defence
- ☐ Right Defence
- ☐ Goaltender

11. On what day of the week did the injury occur on?

- ☐ Monday
- ☐ Tuesday
- ☐ Wednesday
- ☐ Thursday
- ☐ Friday
- ☐ Saturday
- ☐ Sunday

12. Do you know what approximate time of day the injury occurred? (eg. 8:00 P.M., 10:00 A.M.)

_____

13. How long were you prevented from participating in hockey as a result of the injury?

_____

14 How long were you prevented from working as a result of the injury?

_____

15. What activity was involved when you were injured? (Circle appropriate items)

Fighting

Stick Checking (no penalty)

Illegal Stick Checking (penalty called)
- Hooking
- Spearing
- Slashing
- High Sticking
- Cross Checking
- Buttending

Body Checking (no penalty)

Unintended Collision
- With Person
- With Goal
- With Stick
- With Boards
- With Puck
- Fall

Illegal Body Checking (penalty called)
- Boarding
- Tripping
- Roughing
- Charging
- Elbowing
- Interference
- Kicking

No Contact

APPENDIX C

DATE

HEALTH PROFESSIONAL'S
ADDRESS

Dear Health Professional:

SUBJECT'S NAME is presently a subject in a research project examining the types of injuries that occur in recreational ice hockey. The project is being administered by the Department of Health Services Administration and Community Medicine at the University of Alberta.

SUBJECT'S NAME recently visited your office/institution on or about (DATE) for consultation/treatment concerning an injury he received while participating in ice hockey. It is necessary for the purposes of this research project that a an abstract form be filled out concerning the diagnostic specifics of this hockey injury.

With this in mind, I have enclosed an abstract form for you to fill in and a photocopy of the consent form that SUBJECT'S NAME has signed. Any information you provide will be confidential and will be used only as group data in research. If there is any administrative charge for performing this task, please enclose an invoice made out to the Recreational Hockey Injury Study and you will be reimbursed. If you have any questions or comments, do not hesitate to call Don Voaklander at 438-0653.

The study entitled: THE EPIDEMIOLOGY OF RECREATIONAL ICE HOCKEY INJURIES has been reviewed and approved by a duly constituted ethics committee within the Faculty of Medicine at the University of Alberta.

Sincerely yours,

Don Voaklander M.Sc.

APPENDIX C

RECREATIONAL ICE HOCKEY INJURY STUDY
CASE ABSTRACT FORM

Department of Health Services Administration and Community Medicine
University of Alberta
Floor 13 Clinical Sciences Building
University of Alberta
Edmonton, Alberta
T6G 2H9

NAME OF PATIENT_____ DATE TREATED_____

DIAGNOSIS (Please print and check the appropriate BODY PART, CONDITION)

Dx: _____

BODY PART

- ☐ Head*
- ☐ Face*
- ☐ Eye/Orbit*
- ☐ Jaw/Chin*
- ☐ Teeth/Mouth*
- ☐ Nose*
- ☐ Throat
- ☐ Neck*
- ☐ Shoulder*
- ☐ Clavicle*
- ☐ Upper Arm
- ☐ Elbow
- ☐ Spinal Cord*
- ☐ Forearm
- ☐ Wrist
- ☐ Hand
- ☐ Thumb
- ☐ Finger
- ☐ Chest
- ☐ Upper Back
- ☐ Lower Back
- ☐ Coccyx/Sacrum
- ☐ Abdomen
- ☐ Gonads
- ☐ Genitalia
- ☐ Hip
- ☐ Groin
- ☐ Thigh
- ☐ Meniscus
- ☐ Knee
- ☐ Patella
- ☐ Shin
- ☐ Calf
- ☐ Ankle
- ☐ Foot
- ☐ Heel
- ☐ Toes

CONDITION

- ☐ Abrasion
- ☐ Contusion
- ☐ Laceration
- ☐ Strain
- ☐ Sprain
- ☐ Dislocation
- ☐ Fracture
- ☐ Neurotrauma
- ☐ Other (Please List)

WAS A REFERRAL MADE?

- ☐ No
- ☐ Yes

To what health service?

HOSPITALIZED

- ☐ Yes
- ☐ No

PRINCIPAL MANAGEMENT OF INJURY
(Please check appropriate management(s))

- ☐ Surgery
- ☐ Superficial debridement, minor suturing, dental work, etc.
- ☐ Immobilization (cast, splint, etc.)
- ☐ Therapeutic modalities (heat, ultrasound, etc)
- ☐ Prescription medication therapy
- ☐ Proprietary management (aspirin, butterfly bandage, etc.)
- ☐ Rest

OTHER INFORMATION

***For these injuries, please answer on reverse side for detailed diagnosis of injuries**

APPENDIX C

HEAD/SCALP	NECK
☐ Scalp laceration ☐ Cerebral Concussion ☐ Craniocerebral Hematoma, Epidural ☐ Craniocerebral Hematoma, Subdural ☐ Intracerebral Hemorrhage ☐ Skull Fx	☐ Tracheal Contusion ☐ Neck Laceration ☐ Brachial Plexus Stretch Injury ☐ Cervical Spine Sprain/Strain ☐ Spine Dislocation, Cervical ☐ Spine Fx-Dislocation, Cervical ☐ Disk Rupture, Cervical
FACE/EYELID/EYEBROW	**SHOULDER**
☐ Forehead laceration ☐ Eyebrow Laceration ☐ Cheek Laceration ☐ Eyelid Laceration ☐ Zygoma Fx	☐ Shoulder Contusion ☐ Axillary Nerve Compression ☐ Capsule Sprain (Lesion) ☐ Gleno-Humeral Subluxation ☐ Gleno-Humeral Dislocation ☐ Shoulder Strain ☐ Rotator Cuff Strain ☐ Scapula Fx ☐ Humerus Fx
EYE/ORBIT	**CLAVICLE**
☐ Retinal Detachment ☐ Iris Contusion ☐ Periorbital Hematoma ☐ Eye, Globe Contusion ☐ Corneal Laceration ☐ Corneal Opacity ☐ Orbital Blowout Fx	☐ Acromioclavicular Sprain ☐ Sternoclavicular Sprain ☐ Clavicle Fx
JAW/CHIN	**SPINAL CORD**
☐ Chin Laceration ☐ Temporomandibular Sprain ☐ Mandible Fx ☐ Maxilla Fx	☐ Spinal Cord Contusion ☐ Spinal Cord Trauma (Para.) ☐ Spinal Cord Trauma (Quad.) ☐ Spinal Cord Trauma (Death)
TEETH/MOUTH	**NOSE**
☐ Mouth Laceration ☐ Tooth, Luxated ☐ Tooth Fx	☐ Nose Contusion ☐ Nose Laceration ☐ Nose Fx

In case of an injury not included in this list, please indicate under OTHER INFORMATION on reverse side of form.